THE

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THE ROYAL SOCIETY ELECTIONS.

THE election of new Fellows at the Royal Society has this year been attended with rather an excess of individual feeling, apparently brought about by the inability of any one order of scientists to appreciate the work of those whose labours lie either a little above, or a little below, the level of the orthodox, the fashionable, and the crystallised members.

Sir Henry Hoyle Howorth, M.P., is the innocent cause of this exhibition of fine feeling. His labours happen to have been in the remoter fields of history, antiquity and literature, those far-off realms where convocations, *soirées*, and nice distinctions cannot be held, and where the professional element is not yet overwhelmingly strong. The claims of this distinguished candidate were fully set forth by the *Times* of June 2nd. His 90 papers on geology and allied branches of physical science are of the greatest value, as is attested by his candidature being signed by Sir John Lubbock, Sir W. H. Flower, Mr. Franks, Mr. Prestwich, and Profs. Boyd Dawkins, Bonny, and Hughes. If any doubt was held as to his right to election, it is now for ever set at rest by the conclusive majority of about four to one by which the Royal Society created him a Fellow.

His arch-opposers were Messrs. H. E. Armstrong, Ph.D., A. H. Green, E. Ray Lankester, E. B. Poulton, and G. J. Romanes, men who have hitherto done better work.

The methods of nomination of members in scientific societies was discussed in our Journal last December, where it was shown that the most facile way of stepping to the Royal Society is from the professorial chair of some technical school or university. The number of scientific heroes who have gained their colours by this device can be easily comprehended, by a glance along the troops of professors drawn up in Whittaker's Almanac. After looking through this list, we are led to wonder whether the Royal Society of the future is to take the form of a common-room and club for professors, or whether it will cling to its traditions as an organisation for encouraging, honouring, and recording the highest scientific work throughout Great Britain.

The *Times* draws attention to the odd way in which elections to this fellowship are managed. For instance, Mr. Alfred Russel Wallace, whom everyone thought to be a Fellow from, at least, the time of Darwin, has only this year been awarded the distinction. In 1868 the Royal Society granted him a gold medal; but it is only now, in 1893, when Mr. Wallace is 71 years of age, that they have honoured themselves by creating him a Fellow. This we thought an excellent example of the slowness with which natural selection establishes diversities among the species, and proves the universality of the propositions which Mr. Wallace has enunciated; reaching as they do from globigerina depths to the subtle heights of Royal Society decrees; but Prof. G. H. Darwin, writing from Cambridge to our contemporary on the 4th inst, says:—"The election of Mr. Alfred Russel Wallace

to the Royal Society last week has been commented on in the public journals as showing the inefficiency of the method by which Fellows are elected. It seems, therefore, only just to the Royal Society to state that it is notorious that Mr. Wallace would have been elected at any time within the last 35 years if he had ever allowed himself to be nominated."

The new list of Fellows also includes the name of John Isaac Thornycroft, a mechanical and naval engineer, whose torpedo boats, though they are little seen, they (professor-like) have a remarkable way of making themselves heard. The other members are:—Dr. Hobson; Messrs. Ellis, Newton, Sherrington, and Stirling; and the seven professors: Burnside, Dunstan, Ewart, Gairdner, Trail, Worthington, and Young.

From this list it is clear that the professors have determined to support their own order by filling up gaps from their own rank and file. If we remember that they tried to insinuate yet another of their brethren in the place of Sir Henry Howorth, some conception may be formed of the high value at which they esteem themselves. No one will deny that British professors are deserving of an honoured place among the honoured of our country; but this present opinion will be greatly lowered if we find them arrayed in self-placed laurels. Most professors are University men. What they learnt was theory, what they teach is theory, and as theorists we value them. Why do they insist upon ranking above all contemporary workers, and why are the more practical men to be excluded? By "practical men" we don't mean "fools," but we extend the scientific meaning somewhat, so that it may include the greatest geniuses of the age; men whose inventions are now the acknowledged strength of England, while the inventors themselves may be all but unknown at the Royal Society. Professors have need of a little humility before they can fairly claim the high position they are assigning themselves. There is an overbalance of them at the Royal Society, which is giving dignity a one-sided appearance.

NON-SYNCHRONOUS ALTERNATING CURRENT MOTORS.

IT is somewhat refreshing to come across an article on this subject written by a scholar who knows his subject thoroughly well, and who can clearly show us the fundamental principles of these machines. The work of the many investigators on alternating current machinery is gradually drawing towards a focus, and in an article in the *Electrical World*, New York, of May 13th, Dr. Behn-Eschenburg brings many of the views and much of previous workers' experience in alternating current motors to very simple points. The writer of the article goes back to Faraday as the originator of the alternating current motors operated by induction. It seems to some not a little startling to find that from Faraday's simple experiments the principles of the dynamo, the electromotor, the transformer, the alternator, and the alternating motor, are clearly demonstrated. A reference to Faraday's works proved the fact, that he experimented with rotations produced by induced currents, and described them minutely, and we can quite agree with the statement that no man can doubt that to Faraday belongs the credit of discovery in so far as the fundamental principles are concerned, relating to induced currents, and the reactions between induced and inducing currents.

Dr. Behn-Eschenburg calls an alternating current motor an "induction motor" (following Prof. Elihu Thomson), a motor in which the torque is the result of the reaction between the inducing current and the induced current; the inducing current is the field, and the induced current the armature; and induction motors may be single-phase or polyphase motors. In these motors the commutator, if any is used at all, plays a subordinate part, and is introduced merely for the purpose of cutting out or short-circuiting a few coils for the purpose of introducing resistances, or for facilitating the starting of the motor.

The doctor gives an interesting account of the discovery of a single-phase non-synchronous alternating motor in the laboratory at Oerlikon. In running a two-phase Ferraris motor, it was found that after full speed had been attained, the motor continued to run on even if one of the quadrature currents were switched off; it also continued to run when both currents were made cophasedly synchronous, and also when the circuits were thrown into series, that is, energised by the same current. A three-phase motor behaves similarly; if started as a three-phase motor, it can be run by a single-phase current after it has reached an approximately synchronous speed.

Induction motors are treated in this article as transformers. The writer asserts that the single phase as well as the polyphase motor in any position is perfectly analogous to the alternating current transformer. A good motor should, in whatever position the armature may be placed in relation to the field, be the best possible transformer. Constructed on these lines an efficiency of 90 per cent. has been obtained on a 15 H.P. motor.

With the induction motor the old difficulty remains in the way of starting, just as it still remains with the reversed alternator used as a motor; in fact to us the only apparent advantage in the non-synchronous alternating motor, discussed by the author of the article, over the reversed alternator, is that it will run on even below a synchronous speed; how far below that speed we cannot gather.

To start these induction motors with a load on, they must be coupled and started up to synchronism, first as polyphase motors, or be fitted with starting commutators and brushes; the reversed alternator can be, and has been, started with load on by the same devices.

Elmore's Foreign and Colonial Company.

STUDENTS of finance, especially company finance, should not omit to glance at the accounts of this company which we print in another column. Students of "the art of putting things" might also learn something from the directors' report. "The surplus for the year amounts to £224,083," (we omit shillings and pence), "shares and debentures are taken at par, it being impossible to judge of their real value at the present time." The total assets are £350,751. The whole is represented by patents and securities of other Elmore companies, excepting a sum of £336, and of this the most tangible items are cash (£45), and furniture (£128). These are not great offsets to capital (£120,000) and contingent liabilities of a considerable amount. In the assets the French company securities stand for £123,103, the German £95,543, the American for £81,766, and the patents for £50,000. We presume the accountants have no option but to prepare a balance-sheet in

the manner in which this is prepared, but we must say that it might be a very dangerous weapon in the hands of those who are not too scrupulous about misleading investors. When it is remembered that the whole assets of the French company have been sold outright for a mere fraction of its capital; that the German company is apparently behind with its interest payments; and that the American company has no asset whatever but a patent, it will seem that the humour is a little too grim which shows an immense profit because the assets are taken at their nominal valuation in consequence of the difficulty of judging their true value. We could arrive at the true value without much difficulty. In face of this report we are bound to say that we cannot consider the Elmore bubble has ceased altogether to be a public danger.

The New York Electrical Society.

ONCE again we have striking evidence of the good will and active co-operation existing between medical men and electrical engineers in America. Dr. W. J. Morton lectured on May 17th upon "A brief glance at Electricity in Medicine," at the closing meeting of the New York Electrical Society, and the audience was augmented by a contingent of the American Institute of Electrical Engineers. The account of the meeting, given in the New York *Electrical Engineer*, shows that the lecture was most interesting, and the careful attention paid by the distinguished lecturer to the physics of the subject, was a distinct feature. Dr. Morton described the physical properties of the forms of current in medical use, as "heat, light, magnetic induction, chemical-electrolytic and cataphoric; and their physiological properties as contraction of protoplasm, excitation of nerve and muscle and electrotonus." He referred in laudatory terms to the work of M. Gautier of Paris, who "has done inestimable service to medical science by his developments in metallic electrolysis." These researches show that "an iron needle connected to the positive pole, plunged into human tissue, is quickly attacked by the oxygen and chlorine set free at this pole." "A copper needle or bulb, or other conveniently shaped electrode, is converted into oxychloride of copper, zinc into oxychloride of zinc, and so on." In considering the practical application of these phenomena, Dr. Morton was of opinion that "In gynecological work, in nasal catarrh, ozena, unhealthy ulcerations and discharging cavities, it produced antiseptic and healing effects attainable by no other means." A remark of the lecturer, made somewhat later on, that "The ability to secure the best results of cataphoric and electrolytic medication is at present vested, unfortunately, in a limited number of practitioners," borders somewhat on the sarcastic, seeing the extraordinary claims some practitioners have made on this head. It is a very difficult and complicated form of treatment, but we see no reason to disagree with Dr. Morton's conclusion that "the process, in skilful hands, is capable of effecting a certain, safe, and a painless cure." The lecturer concluded with a display of Tesla effects, obtained by Dr. Morton's own method of static induced currents, but as we brought this method to the notice of our readers a short time ago, we need not now further refer to it, interesting as it is.

Electro-Optics.

A RECENT number of *Nature* contains an interesting review of the state of our knowledge concerning what may be termed electro-optics. The paper is signed by A. B. Basset. He describes the action of an electro-magnetic field upon light as one of the most fascinating branches of physical optics, and groups the discoveries which have been made in this department of research under four heads, namely: (1) Faraday's experiments, which show that when plane polarised light is transmitted through a transparent magnetised medium, a rotation of the plane of polarisation is produced; (2) Kerr's experiments, which show that the effect of electrostatic force on a transparent medium is to convert it into one which is opticall equivalent to a uniaxal crystal, whose axis is in the direction of the force; (3) Kerr's experiments on the reflection of plane polarised light at the surface of a magnetised iron reflector, which show that a rotation of the plane of polarisation of the reflected light takes place, which in certain cases is in the same and in others in the contrary direction to that of the ampèrean current which may be conceived to produce the magnetic force; (4) Kundt's experiments on the reflection of light from magnetised iron, cobalt, and nickel, and also on the transmission of light through thin magnetised films of these metals. The author claims that, although Hall's effect *appears* to be intimately connected with the action of a magnetic field on light, further evidence is required. He states that if it be assumed that Hall's effect is capable of existing in transparent media, theory furnishes results which are so far in accord with experiment. Mr. Basset refers to a paper communicated to the Cambridge Philosophical Society on May 1st, which affords additional evidence in favour of his hypothesis, and he thinks that the experiments of Professor Dewar on liquid oxygen might provide a possible method of testing the theory. After discussing the inferences which may be drawn from the experiments of Kerr on the effect of electrostatic force, he concludes by pointing out that further experiments are required of the following order, namely: (1) Experiments on the reflection of light from magnetised transparent media, such as glass, perchloride of iron, and also, if possible, from liquid oxygen; (2) Experiments on reflection from and transmission through magnetised metals, special attention being paid to the effects produced by the non-luminous portion of the spectrum; (3) Experiments on reflection from electrified metallic reflectors.

The Voysey and Hosack Road-Breaker.

THE Road-Breaking Company, Limited, have just completed the permanent design of a tool which should have a large field of practical application before it if the sanguine anticipations of the inventors are realised. A few years ago a well-known electrical engineer, Mr. Arthur Annesley Voysey, was in charge of the contractor's portion of the work of laying the electricity mains in Liverpool. As is doubtless generally known, this city possesses some of the finest examples of street paving to be found anywhere. The extensive use of concrete bottoming even in second class streets is a bugbear to those whose work it is to lay pipes, mains, or other underground works. The idea suggested itself to Mr. Voysey that a machine could be made on the principle of the ore crushing mill which would do away with the expense and loss of time occasioned by manual labour in opening up trenches through the concrete. In the latest design it does not appear that this end has either been kept in view or obtained. Indeed, the machine does little more than scarify or turn up the surface of the road, being evidently intended to do away with the casual labour employed in the repair of worn macadamised roadways. The road-breaker is attached to a steam roller of the ordinary Aveling and Porter form, and in appearance consists of a carriage on broad tyred wheels, having between them a drum carrying the cutting teeth. The drum is driven by pitch chain gearing of ample strength from the motion shaft of the steam roller. There are 18 teeth in all, the section of the teeth being diamond shape, and it is said that the wear on the cutting edges enables them to be used for 3,000 square yards before repair or removal. The weight of the roller is 15 tons, of the Voysey attachment 2 tons 12 cwt., while the drum runs at 60 revolutions. As at present arranged the width of path treated is about 30 inches, while 4,000 to 5,000 square yards can be covered per diem. We shall look out with interest for further developments, but hardly hope that an arrangement of this sort could be made to do anything really serviceable for the cutting of trenches for electric light mains. It is easily seen why.

THE INCANDESCENT LAMP IN WATERWORKS.

THE maintenance of a sufficient and constant water supply to populous neighbourhoods is a most important consideration to local authorities. The staff on a water works is never too numerous, and the performance of the duties for which it is responsible are of prime importance to the community. The load factor of machinery on such premises is rarely allowed to fall below 100 per cent., and with the minimum of labour, continuous day and night running is no light task. An ample head of steam being always available, and engineering talent being present on the spot, it is curious that greater developments in lighting have not been due to the initiative of water engineers.

One meets with candles and oil lamps on visiting a waterworks, for few of such premises are situated within reach of a supply of gas, and the elaborate plant required renders it impracticable to provide a private supply. With electricity the case is very different; the generating machinery appeals to the mechanical engineer, who holds the steam engine in the highest respect. He has only to learn to manipulate the commutator gear of the dynamo, and for the rest to consider the engine-dynamo plant as a machine which takes steam and in return gives out electricity to be used as a lighting agent. When the fittings have once been put up by a good firm, the smallest amount of routine attention would keep everything in good order, and the lighting from being a novelty would settle down to the position of a matter of course. The machinery in connecnection with water supply and purification, is somewhat complex and of considerable size; it depends upon the lighting arrangements to enable the most to be made of the available supply. The lot of the engineman and other employés is no light one. The shifts are in some works of 17 to 19 hours' duration, and the spells of regular work run 12 hours for each man off and on, lasting for 20 days out of 21, so that the dictates of common humanity should cause every consideration possible to be shown to the men at their work.

The Otterbourne Waterworks of The Southampton Corporation have recently been provided with electric lighting and the result has been to emphasise the special value of the incandescent lamp for the purpose. The cottages of the employés have been included in the supply with advantage to the occupants, who fully appreciate the improvement, and the move has brought its reward in the increased attention paid to their duties by the men.

In the works, the water having been raised to the surface, the softening is conducted in a tank; the progress in the precipitation of chalk held in solution being gauged by the gradual change in colour of the effluent. As the process must go on without intermission, the wonder is that electric lighting was not introduced many years ago, for an abundance of pure white light is a necessity to such operations.

There are few places where electricity could be introduced with greater ease and at the same time be so much appreciated as in waterworks and pumping stations, and lighting is but a tithe of the services it could perform when it becomes well-known to the water engineer.

A CURIOUS TRANSFORMER EXPERIMENT.

BY RANKIN KENNEDY.

AN effect not hitherto described was noted while making some experiments with transformer coils, an effect showing that the distribution of the iron inside of the coils of a transformer has a considerable influence on the induction; besides showing this effect, the experiments are instructive and are worth describing, so that they can be repeated.

The coils, A and B, primary and secondary respectively, are made up of No. 16 B.W.G. wire, about 200 turns; the coils are 12 inches long inside and 2½ inches wide; the secondary is laid on top of the primary, into the primary is sent an ordinary alternating current frequency 100 ~ amperes about 7 to 8. To the ends of the secondary a 12-volt incandescent lamp is fixed, under these conditions the lamp is heated only to a very dull red; if now, as in fig. 1, we insert iron stampings, T, of U-shape one by one into the coils, the lamp, of course, brightens up as each stamping is inserted, thus showing the effect of adding iron in the circuit. It will be also observed that the iron stampings tend to fly apart, and stand as far from each other as possible, as shown in fig. 1, and if we press them together as in fig. 2, and then let them go free, they will immediately fly apart. This is easily understood; but it is not so easily understood why that when the lamp is burning brightly with the stampings standing free to choose their own position in the coil as in fig. 1, and then when we forcibly press the stampings together as in fig. 2, the lamp drops at once to a dull red,

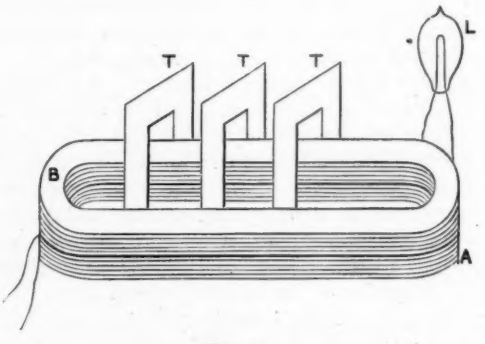

FIG. 1.

showing that the induction is much greater with the iron parted than it is with the iron compactly pressed up as in fig. 2.

The iron stampings are insulated thoroughly with paper and shellac. In both experiments the amount of iron is the same in the coils, yet the mere separating of the plates of iron increases the induction, and bringing them together decreases

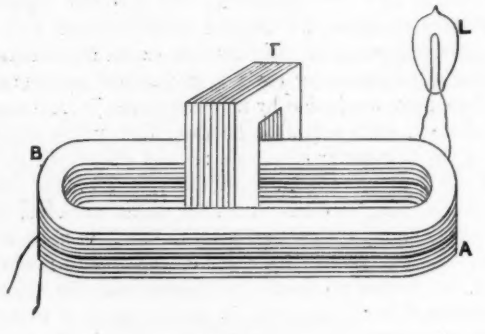

FIG. 2.

it, and all this can be very nicely shown to a class or in a lecture room by the simple arrangement sketched. The lamp makes a splendid galvanoscope, showing the rise and fall of the induction in the coils.

I shall be glad to hear of any explanations anyone may offer.

A considerable number of volt and ammeters are made in which this repulsion of pieces of iron inside a coil carrying a current is made the measure of the current in the coil; in these instruments this effect may play some part worthy of note if the induction is greater when the iron is parted than when close together.

In the Hedgehog transformer the parting of the iron wires at the ends of the coils very greatly increases the induction through the coils. By this experiment it is found that parting the iron inside of the coils also increases the induction through them.

ARC LIGHTING.

BY E. TREMLETT CARTER.

(*Continued from page* 650.)

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II.

IN making the calculations for the most economical section of copper, an assumption as to the quality and price of the insulated cable must be made, as we have already seen. Strictly taken, the thickness of the insulation, as well as the size of the conductor, should be determined by the economic law. But there are considerations which, in most cases, outweigh that of the *cost* of insulating material; and it is customary to decide the quality of insulation, in megohms per mile, by the help of experience rather than by calculation. The price of the cable per square inch of copper will, therefore, be a fixed quantity for any given size of cable, and it will be necessary to have some idea of the approximate section of the cable in order to determine that price. This will present no difficulty, as the engineer will be able to predict whether the cable will be about one-tenth or 1 or 10 square inches in section. The cost of bare cables is strictly proportional to the weight, but of covered cables follows a more complex rule. Most of the manufacturers' prices are proportional to the section of copper plus a constant. Thus, the price of one mile of 37-strand Silvertown cable, Class D, is equal to (£22 5s. + £3,320 A), where A is the section of copper. Only the variable part of this equation to the price is to be utilised in estimating the economic section, and to this part must be added the other charges which are proportional to the section of copper, such as a portion of the labour and freightage, and a certain part of the cost of the conduit.

But, the current density having been scientifically determined, it may happen—it often will happen—that the resulting conditions are utterly impracticable. For example, it may occur that the current density will be so high as to heat the copper to a temperature which will injure the insulation; or it may so happen that, with only a limited number of volts available on the dynamo, the fall in voltage will not leave enough for all the lamps. Again, it sometimes is necessary to have as little loss in the copper as possible, not because power is *dear*, but because only a limited amount of it is to be had. As an instance of this last case, the author may mention the design of a plant which came under his own control; it was for transmitting a certain amount of water power from a fall to a mining centre, and so valuable was every trifling amount of power in enabling the extraction of gold to be carried out as fast as possible, that the directors were able to pay for a cable having far more copper than would be fixed by the ordinary economic law. Here, it was not what the power would cost, but what money the power would realise if utilised, that entered into the calculations. Where the power is used for arc lighting, this case may have a parallel in the demand for as much light as can possibly be got from the limited power available. Finally, the current density, which is fixed by economic laws, may result in a cable which will be too weak to stand the stresses which will be put upon it. This is especially the case in the series lighting of small arc lamps, where the current—8 or 10 amperes—would take too thin a cable if a high density were used.

Having, then, fixed upon the most economical conditions, it will next be necessary to test them in respect of other requirements. The rise in temperature of a cable when working at full current is a matter which has not yet been fully determined. So much depends on the environment of the cable, that what will be true of a cable in one form of conduit, may not be true of the same cable if placed in another form of conduit; while the behaviour of bare copper wires is different from that of covered copper. Again, the permissible rise of temperature, and therefore the current density, may be greater in a cable placed in the Arctic regions than in a similar one on the equator. As regards this country, the Board of Trade has fixed the limit of rise of temperature to 30° F. above surrounding temperatures; and the best manufacturers are able to inform one as to the safe limit of current density for each of their qualities of cable. As a rule the current density is within safe limits if it is less than 1,000 amperes per square inch, unless the cable is very large; and as a rule, the economic density works out very much below this figure.

Mechanical strength in a cable can be had by avoiding too small a section of copper. Where the cable is subjected to being drawn into conduits, or is suspended from poles, it is not safe to employ a smaller size than 7 strands of No. 20 copper wire, however small may be the current. At a density of 1,000 amperes per square inch, this cable would carry 7 amperes. Covered cable is usually stranded, and it is not advisable to use larger strands than No. 14 S.W.G.; bare cables are either in the form of strands or of thin strips of sheet copper placed side by side in porcelain or other insulating cleets. The form and size of the copper, together with its arrangement in the conduit (see par. 7), are affected by the kind of current. If continuous current is used, the form of the cable is only affected by the question of cooling; and a thin strip will cool faster and carry more current safely than a stranded wire of the same section, owing to its more extensive surface. With alternating currents, besides this cooling effect, there is another which favours thin strips in preference to round copper; it is the phenomenon of mutual induction between the elements of the conductor. It is well known that if two wires, insulated from one another, are placed parallel and a current is started in each, the growth of the current in each will hinder the growth in the other. Precisely the same effect goes on in a thick conductor when the current in it varies. The change of current in each part hinders the change in every other part; and the effect of this when there is an alternating current is to prevent altogether the flow of any portion of current through the inner parts of the copper, if the thickness exceeds a certain figure. With 100 alternations per second, the current does not penetrate to a greater depth than about 5 or 6 millimetres, so that any portion of the copper which is further from the surface than this is completely useless. For any given section, the material can be brought nearer to the surface if a rectangular strip is used instead of a circular section. On the other hand, it has not been found practicable to employ covered strips of copper for cables, and bare copper is not adapted to high voltages, so that for many arc lamps in series, where the voltage must be high, one is obliged to use covered stranded copper. Such cables, if designed for large alternating currents, must contain an inner core of fibrous material, over which the copper strands will be laid; this core being of such a thickness, that with the proper number of strands, the radial depth of the copper will nowhere be sufficient to cause the "skin effect" of the alternations. According to a number of experiments conducted by Mr. Mordey, of the Brush Company, the following table expresses the virtual resistance of copper conductors with alternating currents:—

Alternations per second.	Diameter of solid wire in mm.	Current in conductor.	Percentage increase of resistance.
80	10	55	less than 0·01
80	15	133	2·5
80	20	220	8·0
80	25	...	17·5
80	40	...	68·0
80	100	...	380·0
80	1,000	...	3,500·0
100	9	45	less than 0·01
100	13·4	98·5	2·5
100	18·0	178·0	8·0
100	22·4		17·5
133	7·75	32·0	less than 0·01
133	11·61	74·0	2·5
133	15·5	131·4	8·0
133	19·36	...	17·5

In the third case, where the economic law must be modified, namely, where there may be only a certain pre-arranged loss of volts in the cable, it is usual to design the cable in the following manner. Let V be the loss of volts in the entire length of cable; let C be the maximum current which is to be carried; let R be the resistance at the working temperature of a foot of the copper one square inch in section, and let S

be the required section of copper in square inches, and L the total length of it, in feet; then—

$$S = \frac{R \cdot L \cdot C}{V}$$

Turning next to the question of insulation, we shall see that, although it is not customary to apply the economic law formally to determine its amount, yet the usual practice is based indirectly on that law. For it would obviously be impracticable to employ the same quality of insulating material where power has to be transmitted several miles, as where it is generated within a few hundred feet of the lamps; in the latter case we might use the best rubber cables, with an insulation resistance of some 2,000 megohms or more per mile, while in the former case we should have to use overhead bare wire, and would be obliged to get a high insulation by means of oil cup insulators. In the first place, however, we must notice that the object of insulation is to prevent more than a certain leakage of current; and that therefore we must make the insulation high in proportion to the voltage at which the cables are run. Leakage does not merely mean loss of power; it also involves the plant in considerable depreciation, and in some cases in risk of fire. Even where power is very cheap, it does not pay to allow of excessive leakage, and for the reasons just stated. Leakage at any part of the circuit takes place in two directions, to the earth and from one cable to the other. Leakage to earth is proportional to the absolute potential of that part of the cable; leakage between any two parts of the cable depends on their own difference of potential. In a series circuit that is uniformly insulated, therefore, there is the greatest leakage to earth at the dynamo ends of the cables, and the least at their most remote ends; while, if the cables are placed side by side, there will also be the greatest and least leakage between one another at these same points, respectively. It may in some cases pay to employ a higher quality of insulation for the part of the circuit which lies nearer to the generator than for the part at lower voltage; for the first, 800 or 1,000 volts, for example, in a 2,000-volt series circuit; or, to take a second example, in a circuit of, say, 20 lamps in series, it might be well, and it certainly would be economical of current, to have a higher insulation on the five lamps on each cable which were nearest to the dynamo, and a lower insulation on the remaining lamps.

6. *Parallel Systems.*—There are two parallel systems of lighting by arc lamps, the low tension direct and the high tension transformer systems. The first of these is commercially impracticable on a large scale, on account of the heavy currents which the mains would be obliged to carry; but it is sometimes used on small circuits, and especially where arc lamps must be run on the same circuit with glow lamps. In wiring shops, for example, it sometimes occurs that the interior lighting is to be effected by 16 C.P. glow lamps, while the windows are lit by small arcs, taking about 7 or 8 ampères. The simplest plan in such a case is to design the wiring for 50 or 55 volts, and to put arcs and glow lamps all in simple parallel. But if the circuit must be at 100 volts, the glow lamps may be put in parallel, while the arcs may be put in pairs in series, the pairs being in parallel with the glow lamps. Electrical engineering has, perhaps happily, not reached that degree of refinement at which it is considered necessary to apply the economic law to each private installation, chiefly because the engineer could not predict within a very wide error what would be the load factor on the separate branches of the circuit. The consumer is at liberty to use the lights as little or as often as he pleases. Besides, even in wiring for a few small arc lamps in parallel, the cost of the wire and cable is so small compared to the fixed charges, that a very considerable range of current density would but little affect the price. It is customary in such cases to keep the current density within the limit prescribed by the insurance company, and to select the density under this which will give a reasonably small drop from the switchboard to the most remote lamp where all the lights are on. In a two-wire simple parallel system, with the same current density in both conductors, if the working percentage conductivity of the copper may be taken at 95, then the maximum distance between the switchboard and the most remote lamp for a 2-volt drop is given in the following table. The distance is in feet, and includes both lead and return cables.

Current density	500	600	700	800	900	1,000
Distance ...	469	390	335	293	260	234

With a density of 1,000 ampères per square inch, for example, the furthest lamp must be within 117 feet of the switchboard, measured along the casing, *i.e.*, half of 234 feet. The conductors are as a rule of stranded copper, the separate strands being not larger than No. 16 or No. 18 S.W.G.; and the insulation resistance should not have a lower standard than 600 megohms per mile, and is preferably higher than this.

The street lighting of Oxford affords a good example of parallel arc lighting (in groups of two lamps) across low tension mains. It will be described in the sequel.

But, if the parallel direct lighting by means of arc lamps is essentially restricted, the parallel transformer system is capable of almost unlimited extension. In this system we have all the economical advantages of small currents, for the primary voltage may be as high as desired, together with the possibility of almost unlimited extension which accompanies the arrangement of lamps in parallel. Power is supplied to a high tension network of conductors, from a number of alternators, which may either be run in parallel or on separate sections of the district supplied; and on this network the primaries of the transformers are placed in simple parallel, each one working at practically the same voltage. Each transformer is placed in the frame of a single arc lamp, which it supplies with energy at 50 or 55 volts. The network of primary mains is supplied with power at a number of feeding points, by means of high voltage feeders; and as the load on each section increases, through the addition of new lamps, it is simply necessary to run a fresh feeder to a mid point in the overloaded section, in order to prevent too great a drop between the feeding points and the furthest lamp. The problem is essentially the same as that for the distribution of high tension alternating currents for glow lamps; and it is usual to work both kinds of lamps from the same primary mains. This system has received considerable favour in America, and will doubtless be extensively adopted in this country, wherever arc lighting has to be done over a large area. Occasionally there will be two stages of transformation necessary; as where power is transmitted several miles at a very much higher voltage than the network. Power sent from Niagara to Buffalo, for instance, would require some 50,000 volts to be economically transmitted; at Buffalo this would be transformed to 1,000 or 2,000 volts, at one or more central points, at which latter voltage it would be distributed to the low tension transformers.

In any case there will be two, and in the last-mentioned case there will be three, kinds of cable to design, namely, the high tension feeders, the network, and, where employed, the extra high tension transmissive conductors. Usually, the first two will be of covered copper, while the last-named will be of bare wire, oil insulated, on poles. A feeder carries practically the same current throughout its entire length, and is of uniform section. Its function is to take the load at the generator at some regulated and variable voltage, and to deliver it at a feeding point in the network at a fixed and unvarying voltage. The variation of the voltage at the generating end is determined by the load on the feeder, and is designed to compensate the change in drop which accompanies each change in current through the feeder. The amount of this drop at full load, and therefore the section of the copper, is fixed by the economic law, and is rarely affected by any other considerations. In other words, the current density which is determined by the law which was given in the preceding section will not usually be too high to be safe, and will not often be modified by considerations of regulation of voltage at the transformers. The data for the calculation, and the method of applying the law, are the same as for the series system. To take a concrete case, let it be required to design a pair of copper cables to deliver a maximum of 200 H.P. at 1,000 volts at the feeding points. Let the estimated cost of 1 E.H.P. year be £30; let the cost of additional copper be at the rate of £250 per square inch per 1,000 feet, and the rate of interest and depreciation 6 per cent., and let a load factor of 20 per cent. represent the probable average for the immediate future. Then, taking the quality of copper as having a working resistance of 0·00853

ohm per square inch per 1,000 feet, we arrive at the following calculation :—

$$\text{Max. current} = \frac{746 \times \text{H.P.}}{\text{V}} = 150 \text{ ampères.}$$

$$\text{Economical section} = \cdot 873 \times 150 \sqrt{\frac{0{\cdot}00000853 \times 30 \times 20}{6 \times 250}}$$

$$= 0{\cdot}304 \text{ square inch.}$$

The cable for this might well consist of 10 strands of No. 16 S.W.G., and would have a current density of nearly 500 ampères per square inch at full load. If the total length of the two feeders were 4,700 feet, the maximum drop would be about 20 volts, so that the generator would at full load be required to develop 1,020 volts.

(To be continued.)

THE SORROWS OF THE L.E.S.

THE London Electric Supply Corporation has, perhaps, unfortunately for itself, a name to which it is hardly entitled by actual facts. Familiarly known as the "London Company" it is far from the proud position it once occupied of being what its name implies. Fair criticism has always been its portion with us, but unhappily some of our contemporaries have not always shown the same magnanimity to the concern which, despite its past financial troubles, has taught us some useful electrical engineering lessons. The feasibility of extra high pressure working was first demonstrated by the scheme of Mr. Ferranti, and there is a strong feeling of hopefulness that when its time comes it will reach the position of commercial success, of which not even its severest critics would attempt to deprive it. It has had to bear the inevitable penalty of those ideas which come before the time is ripe for their fruition, and, hard as the lot of those unfortunates is, it is sorry work to make capital out of their mishaps. The gas journals have not been quite blameless in this matter, and it is with considerable satisfaction that we note the tendency to a more dignified and impartial tone when reference is made to the Deptford station.

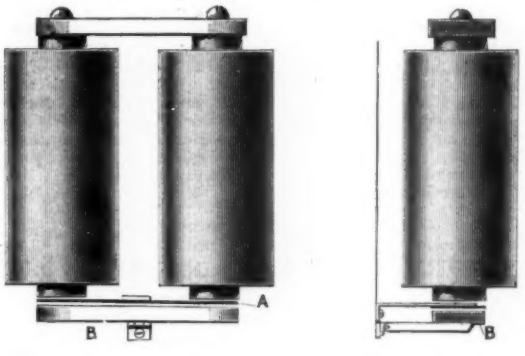
As a step in the right direction the following excerpt from a recent number of a leading gas journal is to be commended. Speaking of the London Electric they say : "The truth of the matter is that whatever the price per unit, they ('the Company') would have found themselves sadly in the rear as compared with their rivals, who have had no such initial troubles to overcome. They began too ambitiously, came to grief, and are now picking up the stray bits of custom that the others have left behind ; so that instead of being able to find adequate work for those grand 10,000 horse-power sets of machinery still lying in fragments at Deptford, the directors have actually had to spend fresh capital in starting a new 300 horse-power unit, which is less than one half the size of the smallest section of plant with which they began somewhere about four years ago."

We are glad to see that the course of misrepresentation and vituperation, which at one time passed for criticism, has at length given place to a calmer and more judicial frame of mind, and, barring the possibility of a relapse, congratulate the writer upon this welcome change.

"NON-STICKING" ARMATURE FOR ELECTRO-MAGNETS.*

AS is well known, considerable difficulty and annoyance is experienced in the use of the electro-magnet by reason of the adherence of the armature thereto after the current has been cut off, such adherence being caused by the residual magnetism. Heretofore the effects of this residual magnetism have been destroyed by the interposition of a thin plate of diamagnetic material, as brass, between the poles of the magnet and the armature. This plate is made of such thickness as to hold the armature without the comparatively feeble field of force of the residual magnetism. Although a very thin sheet of diamagnetic material will effect this purpose, the use of such a plate is objectionable, as it will, however thin, appreciably diminish the power of the magnet when excited, the power decreasing generally as the square of the distance of the armature from the poles of the magnet.

With the object of neutralising the effect of the residual magnetism on the armature without in any way impairing its attractive effect when excited, Mr. S. H. Stupakoff, of Pittsburgh, Pa., has recently devised the arrangement shown in the accompanying engravings. In order to avoid the adherence of the armature after the current has been cut off, by reason of residual magnetism, a strip, A, of iron is interposed between the armature, B, and the poles, so as to extend across from one pole of the magnet to the other. This strip is made of sufficient size to absorb the lines of force of the residual magnetism emanating from the poles of the magnets, but does not constitute a sufficient path for the magnetic lines when the magnets are excited. The strip is supported a short distance away from the poles of the magnet by a resilient tongue attached at its outer end to the frame supporting the magnets, or it may be held in contact with the poles or permanently attached thereto.



When the magnets are excited by the passage of the current, the strip, if held away by a resilient support, will be first attracted to the poles, but as the quantity of metal in the strip is insufficient to serve as a sufficient path for the magnetic lines from one pole of the magnet to the other, the armature will be drawn up against the strip, and as both strip and armature are of magnetic material, they will be practically an integral structure, the armature being held against the strip with nearly the same force as it would be held against the poles themselves. When the current is broken, the strip will act as a sufficient path for the residual magnetism in the cores, and thereby free the armature from all material attractive force.

RELATIONS BETWEEN ELECTRICAL AND INSURANCE INTERESTS.

UNDER the above heading, *The Western Electrician* of America publishes an abstract of a paper read before the Electric Club of St. Louis, by James A. Waterworth.

We have here an insurance official addressing electrical engineers on the relation that exists between the two interests, with the apparent object of showing how they are mutually dependent, one upon the other. Though the one may be concerned in the conservation of energy, and the other in the reduction of the loss ratio, both are primarily interested in the conservation of £ *s. d.* ; and, although self-preservation is the first law of each, the author holds that they are not independent of each other. It seems to us, however, that the inter-dependence of the two interests is more apparent than real. That the prosperity of the electric lighting industry is largely dependent upon the popularity of the light—which to a great extent is a question of safety—will not be disputed. On the other hand the fire offices are independent of its safety as they can equalise matters by special rating if necessary. Fire offices do not exist for charitable purposes, and, although they may in the first instance pay largely for experiment, they generally manage to recoup themselves in the end. At the same time be it observed they are no less subject to the laws of competition than others, and no doubt, therefore, to some extent they are mutually interested with the electrical industry in suppressing the shoddy contractor.

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* New York *Electrical Engineer*.

The paper is smartly written, and we extract the following as a sample of the author's style :—

Electricity was the latest novelty that presented itself to the conservative eye of insurance. The new comer did not make a favorable impression. It was a new and ubiquitous force; it was reported by its best friends to be erratic, whimsical and even dangerous. It was known that it would burn: it was said that it would kill, and it was believed that nobody knew much about it. It was popularly supposed that it took a conjunction of chemist and civil engineer to wire a building so that life and property would be safe. The coming king stepped on the stage with the reputation of an incendiary and anarchist. He claimed the right to enter every house and bring his incendiary habits with him. It was claimed that he could be permitted to enter and remain in a building with reasonable safety if—and here the electrical interests and the insurance interests met. Who was to decide under what conditions electricity could be introduced into our warehouses, factories and homes with reasonable security against setting the town on fire. Electricity brought with it a motley multitude of hangers-on and a foreign nomenclature. A new class of men, known as experts, seemed to spring like an exhalation out of all sorts of occupations—out of tinners' shops and plumbers' stores, and out of boiler and engine rooms. These men knew nothing about electricity, but they soon learned to patter about volts and ampères and short circuits, and they paralysed the boldest citizen with these and such like cabalistic expressions. They spoke with authority and claimed the right to decide what was safe and what was unsafe. In 1888 it took about three weeks to convert a mechanic into an electrical expert. The sudden growth of expert talent beat the record of Jonah's gourd. By a merciful dispensation the expert fungus perished as it had come—in a night. But while these men were contracting and doing work you may readily suppose they did not commend electricity to insurance companies as a harmless innovation. Some of the work done by them would make your hair stand on end. It is being condemned and taken out wherever found, often at great cost.

ELECTRIC LINES AT BADEN AND VÖSLAU, NEAR VIENNA.

[FROM OUR OWN CORRESPONDENT.]

THE recent official inspection concerning the three electric lines in contemplation has had a most unfortunate result. We obtain on this subject the following communication :—

The first question concerns the transformation of the existing Baden tram line into a local electric railway. In the project submitted there was no important modification of the existing installation. On the contrary, improvements were contemplated, consisting, *e.g.*, in laying down groove plates in place of the hitherto inefficient rails, which should facilitate the construction of a good pavement. Further, the traffic was to be worked with electricity instead of with horses. Nevertheless objections were raised by the representatives of the municipality. It was demanded that the electric current should be conveyed, not overhead, but underground, a requirement which is impracticable in roads which are not paved and sewered, so that the project must have been abandoned on this account.

Secondly, as to the Baden-Vöslau project, in the former revision of the tracings, it was emphatically pointed out in the project, on account of the great traffic at the Löwenbrücke, that the Vöslau line was to branch off at this bridge. But now the municipality, or its representatives, reject this resolution on the ground that the Vöslau branch cannot turn off at the Löwenbrücke on account of the extent of the traffic. Further, an adjourned revision for Vöslau is to take place in four weeks, as the plans here were imperfect, and also as the proprietary conditions have been greatly changed in the last year.

Thirdly and lastly, as for the newly projected line from the southern railway station on through the Wilhelm-Franz Road and Allee Street, the question is as follows :—Though the Ministry of Commerce has declared in a decree that in consideration that a considerable advantage will be attainable by the projected junction, since the northern part of the town of Baden, and especially the Bath-house, would obtain a convenient means of communication, hence, without prejudice for an ultimate conclusion, he would permit an official examination of the project, yet the representatives of the municipality and the Bath Commission have raised the most decided objection against the execution of the circular line. Hence the concessionary have received with regret the decision of the municipal representatives and of the Bath Commissioners.

Under such conditions the project can scarcely be realised.

THE ADVANTAGE OF HIGH TENSION IN DISTRIBUTION.

[COMMUNICATED.]

So many times lately have writers on the question of electric lighting endeavoured to explain wherein the advantage lay of using high tension and converters for the distribution of electricity, and yet failed to do more than present their arguments in such an involved way calculated to bewilder rather than enlighten the novice, that we think a simple proof might be of use to them and to the layman whose acquaintance with the subject will not permit him to consistently follow a long argument. When we say "simple" we mean as direct as possible; absolute simplicity is out of the question, and one descends to drivel and baby talk on attempting to achieve that impossible feat—dealing with electrical facts as if they were not electrical but having to do with material substances. The analogies of water, gas and such like media are as a rule pressed to a ridiculous extreme by popular writers, and much as we like plain and simple statements, a beginner could often more easily follow a direct explanation than he could supply the parallel between the laws regulating friction and flow of such bodies and the analogous conditions in electrics. More than once recently this weakness has been manifested, and if a word of warning could put a stop to it we would willingly assist such a good cause.

To be perfectly general, let the conventional signs stand for the numeric of their quantities in each case. The following are required :—

A = Area of cross-section of conductor (is proportional to weight and therefore cost of uncovered copper laid).
R = Resistance (varies inversely with A).
C = Current in ampères flowing through conductor.
E = Electromotive force of supply.
$C^2 R$ = The Joulian formula for energy dissipated as heat in the conductors, *i.e.*, the "loss" in the cables.
ENERGY = C × E = Watts transmitted from supply.

Then (length in all cases being similar) :—

CASE 1.—Say Low Tension.

Conductor referred to.*

Area	= A	Energy	= C E
Resistance	= R	Loss	= C^2 R
Current	= C	Density	= C/A
E.M.F.	= E	Volt drop	= C R

If we find that for a given C E the factor C^2 R is too high to enable the energy to be economically transmitted, then we might consider the use of a higher tension for E (say, 10 E), and see how, why, and where the resultant economy came in.

CASE 2.—Say High Tension. Same actual volt drop.

Conductor referred to.

Area	= $\frac{A}{10}$	Energy	= 10 E × $\frac{C}{10}$ = C E
Resistance	= 10 R	Loss	= $\left(\frac{C}{10}\right)^2$ 10 R = $\frac{C^2}{100}$ × 10 R = $\frac{C^2 R}{10}$
Current	= must be $\frac{C}{10}$		
E.M.F.	= 10 E		
Volt drop	= C/10 × 10 R = C R.	Density	= $\frac{C/10}{A/10}$ = $\frac{C}{A}$

∴ with (10 E) and *same density* as in Case 1., the loss is $\frac{1}{10}$th of the previous value, but the volt drop is the same as in Case 1.

CASE 3.—Say High Tension. Equal per cent. volt drop.

Conductor referred to.

Area	= A/100	Energy	= C/10 × 10 E = C E
Resistance	= 100/R	Loss	= $\left(\frac{C}{10}\right)^2$ 100 R = $\frac{C^2}{100}$ × 100 R = C^2 R
Current	= C/10		
E.M.F.	= 10 E		
Volt drop	= $\frac{C}{10}$ 100 R = 10 C R.	Density	= $\frac{C/10}{A/100}$ = 10 $\frac{C}{A}$

But 10 C R : 10 E :: (Case 1.) C R : E

∴ if we increase the pressure tenfold we can reduce the area of conductor 100-fold and maintain *the same per cent.*

* The sizes of conductors are not drawn to scale but are only inserted to guide the eye.

loss of volts, while with the same per cent. loss of volts the actual watts loss is the same as in the basis example.

Also, if we maintain the *density* (C/A) constant for an increase of pressure *n* times, we reduce the loss of watts *n* times, while the volt drop remains the same for any given density.

Of course, nothing has been said as to the practical conditions, such as the necessary converters, &c., or the loss therein. It is a difficult task to find the simple pressure explanation given understandably and yet in accordance with facts. The advantages, or otherwise, of adopting a H.T. converter system must take into account the question of sites of generating and sub-stations, the cost of, and loss in, converters, the cost of insulating the H.T. cables and so on. As to the copper alone, the economy is well illustrated by the foregoing, which could be understood by any of our average business men. The mind being concentrated directly upon the question at issue, is less fatigued than when called upon to draw analogies between other media and a force like electricity, which is not a media in the way gas and water can be said to be. In laying out the signs the first we take is energy; then the factors of that energy—the current and the pressure. Assuming an average density, we get the terms $A \cdot R \cdot C/A \cdot C R \cdot C^2 R \cdot C E$. On raising E up to 10 E, or for that matter *n* E, the other factors throw themselves in line very easily, C comes first, then A, then R, and the others are resolved out straight away.

It should be remembered that arguments based upon equal lengths of high and low tension conductor are entirely fallacious in their practical bearing. High tension is only used where low tension would be out of the question commercially. Low tension is good for compact areas—nothing could be better. High tension is the only solution where scattered districts have to be dealt with.

Students will easily recognise that the whole gist of the question, and where the saving due to increased tension comes in, is by the value of the current in the loss formula, $C^2 R$, having its numeric squared. This fact is at the root of the whole subject, and should receive the prominence which is its due.

ELECTRO-CULTURE AND THE GEOMAGNETIFERE.

L'imagination galope, le jugement ne va que le pas. This old proverb might well be quoted in respect to a large proportion of the claims which are made for novel applications of electricity: for the tendency to introduce "the new power" into every conceivable operation is only equalled by the extravagance of those who endeavour to exploit such applications. The attitude which we make it our object to preserve towards every fresh departure is well known to our readers and needs no defence, for although the imagination, when properly directed, is a desirable adjunct, its being allowed to run riot can only result in too hasty generalisation.

We are glad to note a change of tone amongst some of our contemporaries towards the subject of electro-culture. When some of the successful experiments were reported, they indulged in pastoral rhapsodies in which they foresaw an end to the troubles of the agricultural community; all the weather gods were to be kept in order or their vagaries rendered futile in the good time that was coming. But even the most enthusiastic of our contemporaries cannot now close their eyes to the somewhat contradictory results which the more recent investigations exhibit. While it is true that many experiments with electricity upon the growth of plants have exhibited very beneficial results, it is equally true that others have been crowned with very indifferent success, the latter being most frequent when they have been conducted on an extensive scale.

A "Report from Commercial Agent Washburn, of Magdeburg," published in *Electricity*, Vol. iv., No. 16, pp. 214-215, reviews the progress which has been made in Germany in the investigation of electro-culture. Latterly experiments with batteries as the source of electricity have chiefly been favoured there, and it is clear that at present neither the favourable nor the unfavourable influence of electricity from such a source can be said to have been clearly established. Indeed, so far as the German researches go, the bulk of the results are decidedly adverse to the employment of electricity as a practical factor in agriculture or horticulture.

It may be, however, that it is not the electricity, but the particular method of application which is at fault, for it is only by allowing this that we can account for the failures and successes of such comparatively recent investigators as Frestier, Barat, Siemens, Grandeau, Leclerc, Wollny, Mallet, Deletris, Spechnew, Lemstrom, Naudin, Bonnier, Lagrange, &c. If all the methods of electro-culture which have been proposed have failed more or less completely, when applied on the large scale, this proves simply that the means employed were defective and does not necessarily involve the failure of a different method. And it must be admitted that negative results, plentiful though they may be, are without convincing force in the face of results that have been positively demonstrated and are reproduced at will.

Whatever system of applying electricity be adopted in helping forward the development of growing plants, it must be one based on economical principles. We have yet to learn that in any of the investigations, carried out on a large scale, which have hitherto been reported, the increased crops showed a profit when the initial cost and the cost of maintenance of the electrical installation were duly taken into account. Hence we think there may be some hope for installations or apparatus worked on such lines as the geomagnetifere. This is a device which has been invented by Paulin, a French monk. It consists of a pole ranging in height from 40 to 60 feet, which is planted in the ground, and sustains, by means of porcelain insulators, a galvanised iron rod, terminating in five copper points at the top. This collecting brush is connected, by means of the rod, with a system of wires 6 feet 9 inches apart, and buried to a depth of 6—18 inches in the soil, which distribute the electricity collected from the atmosphere throughout a certain area. Such an arrangement, 49 feet 2 inches in height, will, it is claimed, influence by means of the system of wires an area of 3,588 square yards.

Paulin thus makes use of an elementary *paratonnerre* with numerous "earths." Such an arrangement obviously lasts for years and by substituting copper for the iron its "life" might be still more prolonged. The Agricultural Society of Montbrison have been so impressed with the results of Paulin's experiments on growing potatoes, vines, radishes, cellery, spinach, sugar, beet, &c., that they have awarded him a medal. It is not difficult to find criticisms on this device, though it is to forego a smile when the porcelain insulators are remembered, but its author has worked upon simple and economical principles, and these, taken in conjunction with the somewhat remarkable crops which he has succeeded in raising, certainly merit consideration.

The whole question of the influence of electricity on vegetation appears to us to be much more complex than is usually supposed. Most of the investigators have assumed that the currents act directly on the plant, but is it not equally proper to assume that they act upon the soil and upon the air entangled in it, perhaps assisting in the fixation of nitrogen—that great plant food—or in rendering the chemical compounds which exist in the soil more assimilable? Such assumptions can be tested, and ought to be carefully examined as to their truth; but it would obviously be a more scientific plan, as we have pointed out before, to accumulate a vast number of observations before generalising, and, we might add, to watch carefully the chemical changes which go on in the soil, whilst it is under the influence of these electrical currents. By such a course the problems which present themselves in considering their influence on vegetation might possibly be made clear.

PROGRAMME OF THE INTERNATIONAL CONGRESS.

THE preliminary programme of the International Congress, to be held in connection with the World's Columbian Exhibition at Chicago about the third week in August, is now drawn up. The "General Congress" will include a smaller body, to be known as the "Chamber of Delegates," which will consist of those specially chosen as representative delegates from the various governments for the purpose of considering electrical units and making recommendations as to the evaluation and legalisation of the units. The opening session of the General Congress is timed for Monday, August 21st, at 3 p.m., when Dr. Elisha Gray, the chairman of the local committee, will open the proceedings, which will chiefly be concerned in the election of officers; the Chamber of Delegates will also assemble for preliminary organisation.

The General Congress will be divided into three sections. (A.) *The Section of Pure Theory*, including electric waves, theories of electrolysis, electric conduction, magnetism, &c. (B.) *The Section of Theory and Practice*, including studies of dynamos, motors, storage batteries, measuring instruments, materials for standards, &c. (C.) *The Section of Pure Practice*, including telegraphy and telephony, electric signalling, electric traction, transmission of power, systems of illuminations, &c. The temporary presiding officers of these sections are:—(A.) Prof. H. A. Rowland; (B.) Prof. Charles R. Cross; (C.) Prof. A. Graham Bell. These sections will probably subdivide as is thought fit.

Papers are solicited upon the following subjects, or upon other topics which may be considered of a suitable character. They should be sent to the Chairman of the Programme Committee not later than August 1st, 1893. Such as are accepted will be put upon the programme of the congress, to be presented in full, or by abstract, according to the time available:—"Magnetic units and modes of embodying them in concrete standards." "Methods of avoiding electrical interference and risks to people and property." "National and municipal testing laboratories." "Materials for standards of electric resistance." "Points of difference of the electrical vocabulary used in different countries." "The direct conversion of the energy of fuel into electrical energy." "Comparison of the various systems of electric distribution." "Alternate current motors." "The behaviour of transformers when supplying power to alternate current motors." "The construction of condensers for alternate current purposes." "The measurement of power in polyphase currents." "Direct coupled and non-direct coupled dynamos." "The use of equalising dynamos in a three- and a five-wire system."

"The use of accumulators in central stations." "The proportions between output of dynamos and the weight of copper and iron employed in their construction." "Electric traction." "Application of electric power in mining." "The adoption of a uniform method of distinguishing positive and negative mains." "Electric supply meters: American, British, Continental." "Criterion of sensitiveness of galvanometers." "Commercial instruments for measurement of electric quantities." "The relation between the voltage of the arc and the quality and composition of the carbons." "The ageing of glow lamps." "The electric working of metals." "The use of electric and magnetic tests for ascertaining the mechanical properties of metals and alloys." "The best material and mode of erection of lightning conductors in view of recent researches in electric discharges." "The prospecting for iron by magnetic surveys." "International telegraphy." "Fast-speed and long-distance telegraphy." "The use of batteries or other generators for telegraphy." "Telegraph lines—land and sea." "Harmonic telegraphy." "Writing telegraphs." "Long distance telephony." "The possibility of providing telephonic communication without wires." "Application of electric signalling to the working of railways (alarms, time, &c.), and to naval and military purposes." "Magnetic separators." "The use of electricity in engraving and in the art of reproduction."

The following topics are down for consideration by the Chamber of Delegates:—"Adoption of definitions and values of fundamental units of resistance, current and electromotive force; also for magnetic units, light-energy and other units." "The standardisation of electric lights." "The consideration of an international system of notation and conventional symbols and a more uniform and accurate use of terms and phrases in electrical literature." "A commercial standard of copper resistance."

LONDON CHAMBER OF COMMERCE.

THE ELECTRICAL TRADES SECTION.

ON the 2nd inst. Major FLOOD-PAGE presided at a meeting of this section, and which had been postponed from the 19th ult. The subjects on the agenda were Overhead Wire Regulations, Electric Traction and Railway Rates; but before dealing with these the Chairman referred to the recent formation by the Chamber of Commerce and the City Corporation of a London Chamber of Arbitration. He said that the matter was of importance to all trades, and that arbitrators representing most of the trades in the metropolis had been secured. It was hoped that all connected with the electrical industries would endeavour to get the insertion in all contracts of a clause which had been decided upon, and which was being done by other trades. That clause, which had been rendered legal by Act of Parliament, and which could not be departed from for any other method of arbitration, was to the effect that "all disputes relating to contracts shall be submitted to arbitration, to the rules for the time being of the London Chamber of Arbitration." He commended that to the consideration of the section. With regard to overhead wires, he had some correspondence, which was not for publication, and which had passed between the Board of Trade and the Institution of Electrical Engineers. They were now in a more satisfactory position than they were a short time ago. The Chairman observed that Mr. Garcke would move a motion asking for power to appoint a sub-committee to raise funds and take such action as might be necessary in the interests of one branch of the industry. That committee would not be controlled by the ordinary rules governing such committees. It was to be regretted that organisations outside of the section had been formed, and the Chamber would be much more useful to the industry if, when questions arose requiring special consideration, they were dealt with in conjunction with the Chamber. It had been suggested in one of the electrical journals that neither the Chamber nor the Institution of Electrical Engineers dealt with purely commercial matters, and that such might be done by the section, in the way of reading of papers and discussions thereon. He would be pleased, if the idea was feasible, if Messrs. Garcke and Siemens, in conjunction with himself, would consider the matter before the winter so as to endeavour to fill the gap and prevent any other organisation being formed to come between the Institution and the Electrical Section.

Mr. CROMPTON remarked that when the matter of overhead wires was considered the other day, it had been thought best that the correspondence should be handed to the members to read, as the Board of Trade were very sensitive about anything being divulged. No doubt matters had advanced a little and the Board would doubtless ask for assistance. If not, they would be entitled to call in the aid of this body to put pressure upon the Board of Trade to again receive a deputation and to intimate that the pressure on the industry was very great.

Major-General WEBBER observed that although the Board of Trade demurred making any important changes unless the necessity for them had been plainly shown, they would be satisfied to learn that the Board were willing to meet the wishes of the Council of the Institution, and at the same time they would be meeting the desires of the Chamber of Commerce. He was of opinion that the Board would meet them in essential alterations.

Mr. GARCKE stated that the proposal he would move was due to the various organisations formed to deal with electrical matters, and to increase the value and scope of the section. The object was to merge the organisation which had already been formed into the Chamber of Commerce. The idea had occurred to him that the Electrical Traction Association, which had been formed to prepare evidence and for other purposes, in view of the Select Committee, *re* tramways, would find it advantageous to accomplish their object by means of a sub-committee of the section, than by a separate association. He therefore moved the formation of an electric traction sub-committee, with power to raise funds, engage counsel, and take such other steps as might be necessary for the advocacy of the protection of traction interests. The members of the committee, with power to add to their number, would be Messrs. Crompton, Morse, Kite, Graff Baker, the Babcock-Wilcox Company, Mr. Garcke, Mr. Sellon, and the Brush Company.

The motion, seconded by Major-General WEBBER, was carried.

With regard to railway rates, the question had arisen through correspondence between the secretary and Messrs. W. T. Glover & Co. This matter was referred to the Railway Rates Committee of the section. The subject of reading papers on purely commercial matters was referred to the consideration of the Chairman, Deputy Chairmen, and Mr. Crompton.

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.*

BY NIKOLA TESLA.

INTRODUCTORY.—SOME THOUGHTS ON THE EYE.

WHEN we look at the world around us, on Nature, we are impressed with its beauty and grandeur. Each thing we perceive, though it may be vanishingly small, is in itself a world, that is, like the whole of the visible universe, matter and force governed by law—a world, the contemplation of which fills us with feelings of wonder, and irresistibly urges us to ceaseless thought and inquiry. But in all this vast world, of all objects our senses reveal to us, the most marvellous, the most appealing to our imagination, appears no doubt a highly developed organism, a thinking being. If there is anything fitted to make us admire Nature's handiwork, it is certainly this inconceivable structure, which performs its innumerable motions in obedience to external influence. To understand its workings, to get a deeper insight into this Nature's masterpiece, has ever been for thinkers a fascinating aim, and after many centuries of arduous research men have arrived at a fair understanding of the functions of its organs and senses. Again, in all the perfect harmony of its parts, of the parts which constitute the material or tangible of our being, of all its organs and senses, the eye is the most wonderful. It is the most precious, the most indispensable of our receptive or directive organs, it is the great gateway through which all knowledge enters the mind. Of all our organs, it is the one, which is in the most intimate relation with that which we call intellect. So intimate is this relation, that it is often said that the very soul shows itself in the eye.

It can be taken as a fact, which the theory of the action of the eye implies, that for each external impression, that is, for each image produced upon the retina, the ends of the visual nerves, concerned in the conveyance of the impression to the mind, must be under a peculiar stress or in a vibratory state. It now does not seem improbable that, when by the power of thought an image is evoked, a distinct reflex action, no matter how weak, is exerted upon certain ends of the visual nerves, and therefore upon the retina. Will it ever be within human power to analyse the condition of the retina when disturbed by thought or reflex action, by the help of some optical or other means of such sensitiveness, that a clear idea of its state might be gained at any time? If this were possible, then the problem of reading one's thoughts with precision, like the characters of an open book, might be much easier to solve than many problems, belonging to the domain of positive physical science, in the solution of which many, if not the majority, of scientific men implicitly believe. Helmholtz has shown that the fundi of the eyes are themselves luminous, and he was able to *see*, in total darkness, the movement of his arm by the light of his own eyes. This is one of the most remarkable experiments recorded in the history of science, and probably only a few men could satisfactorily repeat it, for it is very likely that the luminosity of the eyes is associated with uncommon activity of the brain and great imaginative power. It is fluorescence of brain action, as it were.

Another fact having a bearing on this subject which has probably been noted by many, since it is stated in popular expressions, but which I cannot recollect to have found chronicled as a positive result of observation is, that at times, when a sudden idea or image presents itself to the intellect, there is a distinct and sometimes painful sensation of luminosity produced in the eye, observable even in broad daylight.

The saying, then, that the soul shows itself in the eye is deeply founded, and we feel that it expresses a great truth. It has a profound meaning even for one who, like a poet or artist, only following his inborn instinct or love for Nature, finds delight in aimless thoughts and in the mere contemplation of natural phenomena, but a still more profound meaning for one who, in the spirit of positive scientific investigation, seeks to ascertain the causes of the effects. It is principally the natural philosopher, the physicist, for whom the eye is the subject of the most intense admiration.

Two facts about the eye must forcibly impress the mind of the physicist, notwithstanding he may think or say that it is an imperfect optical instrument, forgetting that the very conception of that which is perfect, or seems so to him, has been gained through the same in-

* A lecture delivered before the Franklin Institute, at Philadelphia, February 24th, 1893, and before the National Electric Light Association, at St. Louis, Mo., March 1st, 1893.

strument. Firstly, the eye is, as far as our positive knowledge goes, the only organ which is *directly* affected by that subtile medium, which, as science teaches us, must fill all space; secondly, it is the most sensitive of our organs, imcomparably more sensitive to external impressions than any other.

The organ of hearing implies the impact of ponderable bodies, the organ of smell the transference of detached material particles, and the organs of taste, and of touch or force, the direct contact, or at least some interference of ponderable matter, and this is true even in those instances of animal organisms, in which some of these organs are developed to a degree of truly marvellous perfection. This being so, it seems wonderful that the organ of sight solely should be capable of being stirred by that which all our other organs are powerless to detect, which yet plays an essential part in all natural phenomena, which transmits all energy and sustains all motion, and, that most intricate of all, life, but which has properties such that even a scientifically trained mind cannot help drawing a distinction between it and all that is called matter. Considering merely this, and the fact that the eye, by its marvellous power, widens our otherwise very narrow range of perception far beyond the limits of the small world which is our own, to embrace myriads of other worlds, suns and stars in the infinite depths of the universe, would make it justifiable to assert that it is an organ of a higher order. Its performances are beyond comprehension. Nature, as far as we know, never produced anything more wonderful. We can get barely a faint idea of its prodigious power by analysing what it does, and by comparing. When ether waves impinge upon the human body, they produce the sensations of warmth or cold, pleasure or pain, or perhaps other sensations of which we are not aware, and any degree or intensity of these sensations, which degrees are infinite in number, hence an infinite number of distinct sensations. But our sense of touch, or our sense of force, cannot reveal to us these differences in degree or intensity, unless they are very great. Now we can readily conceive how an organism, such as the human in the eternal process of evolution, or, more philosophically speaking, adaptation to Nature, being constrained to the use of only the sense of touch or force, for instance, might develop this sense to such a degree of sensitiveness or perfection, that it would be capable of distinguishing the minutest differences in the temperature of a body even at some distance, to a hundredth, or thousandth, or millionth part of a degree. Yet, even this apparently impossible performance would not begin to compare with that of the eye, which is capable of distinguishing and conveying to the mind in a single instant innumerable peculiarities of the body, be it in form or colour, or other respects. This power of the eye rests upon two things, namely, the rectilinear propagation of the disturbance by which it is effected, and upon its sensitiveness. To say that the eye is sensitive is not saying anything. Compared with it, all other organs are monstrously crude. The organ of smell which guides a dog on the trail of a deer, the organ of touch or force which guides an insect in its wanderings, the organ of hearing, which is affected by the slightest disturbances of the air, are sensitive organs, to be sure, but what are they compared with the human eye! No doubt it responds to the faintest echoes or reverberations of the medium; no doubt, it brings us tidings from other worlds, infinitely remote, but in a language we cannot as yet always understand. And why not? Because we live in a medium filled with air and other gases, vapours, and a dense mass of solid particles flying about. These play an important part in many phenomena; they fritter away the energy of the vibrations before they can reach the eye; they, too, are the carriers of germs of destruction, they get into our lungs and other organs, clog up the channels, and imperceptibly, yet inevitably, arrest the stream of life. Could we but do away with all ponderable matter in the line of sight of the telescope it would reveal to us undreamt of marvels. Even the unaided eye, I think, would be capable of distinguishing in the pure medium small objects at distances measured probably by hundreds or perhaps thousands of miles.

But there is something else about the eye which impresses us still more than these wonderful features which we observe, viewing it from the standpoint of a physicist, merely as an optical instrument —something which appeals to us more than its marvellous faculty of being directly affected by the vibrations of the medium, without interference of gross matter, and more than its inconceivable sensitiveness and discerning power. It is its significance in the processes of life. No matter what one's views on Nature and life may be, he must stand amazed when, for the first time in his thoughts, he realises the importance of the eye in the physical processes and mental performances of the human organism. And how could it be otherwise, when he realises that the eye is the means through which the human race has acquired the entire knowledge it possesses, that it controls all our motions, more still, all our actions.

There is no way of acquiring knowledge except through the eye. What is the foundation of all philosophical systems of ancient and modern times, in fact of all the philosophy of man? *I am, I think; I think, therefore I am.* But how could I think and how would I know that I exist, if I had not the eye? For knowledge involves consciousness; consciousness involves ideas, conceptions; conceptions involve pictures or images, and images, the sense of vision, and therefore the organ of sight. But how about blind men will be asked? Yes, a blind man may depict in magnificent poems forms and scenes from real life, from a world he physically does not see. A blind man may touch the keys of an instrument with unerring precision, may build the fastest boat, may discover and invent, calculate and construct, may do still greater wonders—but all the blind men who have done such things have descended from those who had seeing eyes. Nature may reach the same result in many ways. Like a wave in the physical world, in the infinite ocean of the medium which pervades all, so in the world of organisms, in life, an impulse started proceeds onward, at times, may be, with the speed of light, at times, again, so slowly that for ages and ages it seems to stay, passing through processes of a complexity inconceivable to men, but in all its forms, in all its stages, its energy ever and ever integrally present. A single ray of light from a distant star falling upon the eye of a tyrant in bygone times, may have altered the course of his life, may have changed the destiny of nations, may have transformed the surface of the globe, so intricate, so inconceivably complex are the processes in Nature. In no way can we get such an overwhelming idea of the grandeur of Nature, than when we consider, that in accordance with the law of the conservation of energy, throughout the Infinite, the forces are in a perfect balance, and hence the energy of a single thought may determine the motion of a Universe. It is not necessary that every individual, not even that every generation or many generations, should have the physical instrument of sight, in order to be able to form images and to think, that is, form ideas or conceptions; but sometime or other, during the process of evolution, the eye certainly must have existed, else thought, as we understand it, would be impossible; else conceptions, like spirit, intellect, mind, call it as you may, could not exist. It is conceivable, that in some other world, in some other beings the eye is replaced by a different organ, equally or more perfect, but these beings cannot be men.

Now what prompts us to all voluntary motions and actions of any kind? Again the eye. If I am conscious of the motion, I must have an idea or conception, that is, an image, therefore the eye. If I am not precisely conscious of the motion, it is because the images are vague or indistinct, being blurred by the superimposition of many. But when I perform the motion, does the impulse which prompts me to the action come from within or from without? The greatest physicists have not disdained to endeavour to answer this and similar questions, and have at times abandoned themselves to the delights of pure and unrestrained thought. Such questions are generally considered not to belong to the realm of positive physical science, but will before long be annexed to its domain. Helmholtz has probably thought more on life than any modern scientist. Lord Kelvin expressed his belief that life's process is electrical, and that there is a force inherent to the organism, and determining its motions. Just as much as I am convinced of any physical truth, I am convinced that the motive impulse must come from the outside. For consider the lowest organism we know—and there are probably many lower ones—an aggregation of a few cells only. If it is capable of voluntary motion, it can perform an infinite number of motions, all definite and precise. But now a mechanism consisting of a finite number of parts, and few at that, cannot perform an infinite number of definite motions, hence the impulses which govern its movements must come from the environment. So the atom, the ulterior element of the Universe's structure, is tossed about in space eternally, a play to external influences, like a float in a troubled sea. Were it to stop its motion *it would die.* Matter at rest, if such a thing could exist, would be matter dead. Death of matter! Never has a sentence of deeper philosophical meaning been uttered. This is the way in which Prof. Dewar forcibly expresses it in the description of his admirable experiments, in which liquid oxygen is handled as one handles water, and air at ordinary pressure is made to condense and even to solidify by the intense cold. Experiments which serve to illustrate, in his language, the last feeble manifestations of life, the last quiverings of matter about to die. But human eyes shall not witness such death. There is no death of matter; for throughout the infinite universe all has to move, to vibrate, that is, to live.

I have made the preceding statements at the peril of treading upon metaphysical ground, in my desire to introduce the subject of this lecture in a manner not altogether uninteresting, I may hope, to an audience such as I have the honour to address. But now then, returning to the subject, this divine organ of sight, this indispensable instrument for thought and all intellectual enjoyment, which lays open to us the marvels of this universe, through which we have acquired what knowledge we possess, and which prompts us to, and controls, all our physical and mental activity. By what is it affected? By light! What is light?

We have witnessed the great strides which have been made in all departments of science in recent years. So great have been the advances, that we cannot refrain from asking ourselves, Is this all true, or is it but a dream? Centuries ago men have lived, have thought, discovered, invented, and have believed that they were soaring, while they were merely proceeding at a snail's pace. So we, too, may be mistaken. But taking the truth of the observed events as one of the implied facts of science, we must rejoice in the immense progress already made, and still more in the anticipation of what must come, judging from the possibilities opened up by modern research. There is, however, an advance which we have been witnessing, which must be particularly gratifying to every lover of progress. It is not a discovery, or an invention, or an achievement in any particular direction. It is an advance in all directions of scientific thought and experiment. I mean the generalisation of the natural forces and phenomena, the looming up of a certain broad idea on the scientific horizon. It is this idea which has, however, long ago taken possession of the most advanced minds, to which I desire to call your attention, and which I intend to illustrate, in a general way, in these experiments, as the first step in answering the question "What is light?" and to realise the modern meaning of this word.

It is beyond the scope of my lecture to dwell upon the subject of light in general, my object being merely to bring presently to your notice a certain class of light effects and a number of phenomena observed in pursuing the study of these effects. But to be consistent in my remarks it is necessary to state that according to that idea, now accepted by the majority of scientific men as a positive result of theoretical and experimental investigation, the various forms or manifestations of energy which were generally designated as "electric," or more precisely "electro-magnetic," are energy manifestations of the same nature as those of radiant heat and light. Therefore the phenomena of light and heat, and others besides these, may be called electrical phenomena. Thus electrical science has

become the mother science of all, and its study has become all important. The day when we shall know exactly what "electricity" is, will chronicle an event probably greater, more important than any other recorded in the history of the human race. The time will come when the comfort, the very existence perhaps of man will depend upon that wonderful agent. For our existence and comfort we require heat, light, and mechanical power. How do we now get all these? We get them from fuel, we get them by consuming material. What will man do when the forests disappear, when the coal fields are exhausted? Only one thing, according to our present knowledge will remain; that is, to transmit power at great distances. Men will go to the waterfalls, to the tides, which are the stores of an infinitesimal part of Nature's immeasurable energy. There will they harness the energy and transmit the same to their settlements, to warm their homes by, to give them light, and to keep their obedient slaves, the machines, toiling. But how will they transmit this energy if not by electricity? Judge then, if the comfort, nay, the very existence of man will not depend on electricity, I am aware that this view is not that of a practical engineer, but neither is it that of an illusionist, for it is certain that power transmission, which at present is merely a stimulus to enterprise, will some day be a dire necessity.

It is more important for the student, who takes up the study of light phenomena, to make himself thoroughly acquainted with certain modern views, than to peruse entire books on the subject of light itself, as disconnected from these views. Were I, therefore, to make these demonstrations before students seeking information—and for the sake of the few of those who may be present, give me leave to so assume—it would be my principal endeavour to impress these views upon their minds in this series of experiments.

It might be sufficient for this purpose to perform a simple and well-known experiment. I might take a familiar appliance, a Leyden jar, charge it from a frictional machine, and then discharge it. In explaining to you its permanent state when charged, and its transitory condition when discharging, calling your attention to the forces which enter into play and to the various phenomena they produce, and pointing out the relation of the forces and phenomena, I might fully succeed in illustrating that modern idea. No doubt, to the thinker, this simple experiment would appeal as much as the most magnificent display. But this is to be an experimental demonstration, and one which should possess besides instructive, also entertaining features, and as such, a simple experiment, such as the one cited, would not go very far towards the attainment of the lecturer's aim. I must therefore choose another way of illustrating, more spectacular, certainly, but perhaps also more instructive. Instead of the frictional machine and Leyden jar, I shall avail myself in these experiments of an induction coil of peculiar properties, which was described in detail by me in a lecture before the London Institution of Electrical Engineers, in February, 1892. This induction coil is capable of yielding currents of enormous potential differences, alternating with extreme rapidity. With this apparatus I shall endeavour to show you three distinct classes of effects, or phenomena, and it is my desire that each experiment, while serving for the purposes of illustration, should at the same time teach us some novel truth, or show us some novel aspect of this fascinating science. But before doing this, it seems proper and useful to dwell upon the apparatus employed and method of obtaining the high potentials and high-frequency currents which are made use of in these experiments.

(To be continued.)

THE NEW SUNBEAM INCANDESCENT LAMP.

THE continuous run of legal success which has attended the Edison lamp patent in the States (the reverse lately experienced excepted), has had the effect of stimulating certain inventors into attempting to devise new forms of incandescent lamps. Some months ago, the Westinghouse Company announced a non-infringing stopper lamp. Now, another type, called the new Sunbeam lamp, is described, and for this latter form some very remarkable claims are made. The originator of the lamp is Mr. John Van der Kammer, and an American contemporary gives some particulars of it in a recent issue in very glowing terms. Specific constructive details are, however, notable by their absence. In general appearance the lamp is not unlike the rest of its genus; though, to be accurate, the bulb and neck are somewhat different in shape. It differs from other lamps, however, in having a metal base, and in being charged with a peculiar rare gas. With regard to the metal stopper the description given is somewhat confused; so, lest we should misrepresent it, we quote as follows:—"... the lamp embraces the features of a glass globe combined with a metallic base, somewhat after the manner of some of the very early lamps which preceded the vacuum lamp, the circuit being formed of wires secured to the inside of such base [the detail of explaining how it happens that a short circuit does not occur through the metal base is not worth referring to, apparently], and the burner itself, the two ends of which are connected to the two inside wires in much the usual manner. .... Mr. Kammer's method of securing the metallic plates to the glass portions of the receiver is exceedingly ingenious .... [but readers are tantalised by not having the method explained]. The difference in expansion between the metal base and the glass is of no consequence in a lamp constructed in this manner, for there is sufficient flexibility in the metal to permit it to accommodate itself to the expansion of the glass. The metal base can therefore be made of some of the baser and cheaper metals, as, for example, copper. This lamp, however, not being a vacuum lamp, the character of the gas is such that the base can be most easily made of some metal which will resist the action of such gas, as, for example, platinum. The manufacturers promise soon, however, to employ in place of the platinum some cheaper metal, preparing it in advance, so as to resist the action of the gas." Comment is needless on these extracts.

Importance is laid on the circumstance that owing to the comparatively high pressure of gas used, the maintenance of a perfect vacuum chamber is of less consequence. The reason the inventor assigns for discarding the vacuum is that a "vacuum lamp being based upon the idea of a perfect vacuum, and a perfect vacuum being unattainable, the lamp must of necessity retain within itself the cause of its own early destruction, and in practice it is found that the vacuum lamp, as ordinarily made, is quickly destroyed by comparatively slight excess of current." As a sequence of this logical and convincing reasoning, "the inventor set himself the task of constructing a lamp on the principles of the earlier gas lamps," and the results of his experiments are stated to be "both surprising and gratifying." One marvel is that although the new lamp contains a considerable quantity of gas, it is even cooler when running than ordinary vacuum lamps. Another is, that there is no disintegration of the carbon, and 100-volt lamps may be run at 150 volts for a considerable time, and yet "the burner will be found to be of its normal colour throughout." The gas possesses other astonishing properties: "Whatever injury the burner receives, or tends to receive from overrunning, is promptly and completely repaired by the gas itself." It is a little remarkable that the gradual leakage of air into the bulb, which must occur through the joint between glass and metal, which it is admitted is not absolutely airtight, should not have the effect of injuring the carbon filament. The healing properties of this wonderful gas must indeed be surprising. Another difficulty which arises in the critic's mind is the fact that the degree of incandescence of a filament varies considerably with the quantity of gas in the bulb, and it is difficult to see how the pressure of gas should remain constant in a receiver which is not perfectly air tight. But doubtless this extraordinary gas, which does not become heated, is able to make the lamps of uniform incandescence, in addition to its other valuable properties. It becomes a matter of considerable interest—comic theatre interest—to know something of a definite nature about this gas, but curiosity on the point is very slightly gratified. Delay in producing these lamps is attributed largely to the "difficulty of obtaining the gas-producing substance in sufficient quantities to answer the purposes of the manufacturer. The gas which is employed is produced from a very rare substance, and one which the inventor and the chemical experts of the company assert has never before been used in connection with incandescent lamps, and which it is very difficult to obtain." The article refers to other advantages of this brilliant invention, but we will conclude here by expressing the opinion that the Star Electric Lamp Company, which is exploiting the invention, will have to devise yet another form of non-infringing lamp before it can expect to make the General Electric Company quake.

TELEGRAPHIC COMMUNICATION IN THE WEST INDIES.

How Trade and Intercourse may most Successfully be Restricted within the Narrowest Limits.

BY DR. R. B. ANDERSON.

I FIND my heading a very useful text, well suited to the circumstances and conditions with which I have to deal, and by no means unduly cynical or satirical. The cynicism and the satire are in the facts, and not in my statement of them.

Since my last article was written, I have found further justification of my heading in the refusal of the West India and Panama Company to take any part in promoting the changes in the mail service to the West Indies, which not only Messrs. T. Cook & Son, but I venture to think, all persons concerned and qualified to form a correct opinion, consider likely to be of great service in promoting travel from this country to the West Indies.

I shall revert to this later, when further steps have been taken, and I am in a position to report progress in a matter which, though indirectly, is certainly of importance in relation to the development of telegraphic business. Yet I have to admit that enquiry and investigation show that very similar tendencies to those that hamper the West Indies are apparent in some other quarters of the world, as well; where monopolies—though not, I think, in mail steamers—still exist; and where companies, and boards of directors, measure out cable by the mile, and communication by the word; and I believe that where not even apparent they are latent, and that their control is due to opposing factors, the like of which we have not got in the West Indies.

Mr. Heaton, in the *Contemporary Review* for April, 1893, describes Sir John Pender as the soul of a great combination, comprising many telegraphic companies, that is practically a monopoly in possession of all telegraphic communication with India and the East. I may, perhaps, be permitted to quote Mr. Heaton's words in this and some other very interesting passages of his article.

"The cable system of the world is in English hands, but it is in the hands of a few monopolists. . . . And the soul of the combination is Sir John Pender, a man of consummate ability. His rule may be described as despotism, tempered by the fear of competition.

He holds the keys that might unlock the chained sympathies of our race, but he will not use them. He stands like a sinister angel between father and son, mother and daughter, brother and sister, and his one aim is to make as much profit for his shareholders as possible from his monopoly, before Parliament intervenes."

One might expect this to be followed in appropriate tones by the denunciation of Cæsar. "Why, man, he doth bestride the narrow world like a Colossus." I cannot help having, rather, towards the men of giant enterprise like this, aye and even as to Carlyle's much abused Hudson, the railway king, the feeling that, dividends or no dividends, they are the true "Puck," the true "Ariel" of our race and age. Science is the Oberon—or the Prospero—but capital is accumulated human labour, accumulated human wisdom, and in some respects at least, accumulated human virtue too; and whilst our Oberon or our Prospero, Watts or Stephenson, or Galvani, or Edison, seek into and discover the hidden forces of nature, and the laws that harmonise and co-ordinate them, Puck or Ariel carries out the necessary arrangements;—Sir John Pender places "A girdle round the earth in forty minutes;"—or Ariel lays down a railway and builds a locomotive. And Sir John Pender (representing all his shareholders) like Puck, or Ariel, looks for release from labour as the reward for a task accomplished; and no doubt he, and they, will take their release when the dividends accumulated secure them, in their own idea, ease and comfort. I do not think the natural wish to make his release the more speedy, to increase his dividends, places Sir John in the odious position of a sinister angel, so pathetically appealed against by Mr. Heaton; though perhaps Mr. Heaton does not "give it" to Sir John worse than Prospero did for a like offence to Ariel.

Mr. Heaton says: "I have already quoted the evidence of an *employé* of the cable companies to the effect that not more than one in a hundred of the messages (between Australia and other countries) were family or social messages; and it is practically certain that during the period since 1872, not one of the many humble and honest toilers at the Antipodes has been able to cable to his 'old folks' in the mother country one word of intelligence or sympathy, however deeply he might have longed at critical moments to send that word, and they to receive it."

Mr. Heaton omits from consideration that but for the application of the capital employed in laying the present system, none of the honest toilers aforesaid would have enjoyed any of the indirect advantages of increased commerce and public news that they now enjoy; and when he goes on as follows: "A beneficent invention, the common heritage of our race—one that might enable all Christendom to assemble, as it were, under one roof, there to talk, laugh and weep together, has been selfishly appropriated by a few speculators," I cannot help feeling that he is placing his own cause at no inconsiderable disadvantage, by misleading the minds of his many thousands of readers as to the true issues involved.

The whole present telegraphic system consists of successive and separate inventions and improvements, each of which, and therefore all of which, far from being "the heritage of the race," were the *absolute* property, in a way that no other property than these brain products can be, of the individuals who invented them—for those individuals, so far as each was concerned, could have relegated them to oblivion, without the possibility of prevention.

And to say to the courageous capitalist, who found the necessary "funded labour" to tempt the inventor to part with them, and to enable them to be put to the test of experiment and of use; who took, in doing so, the risk of finding them useless, or soon superseded, as well as the hope of success *and of fortune*, that he should be permitted to do so only upon the condition that, if they proved a success, the "race" might then claim them as a "heritage;" whilst if they proved a failure, the "race" should repudiate their "heritage," and all obligation to share the loss of those who had ventured the experiment, would be to say that capitalists should no more buy—or inventors sell—inventions.

The invention becomes the "heritage of the race," when the race acquires it by paying the price of it, which may or may not have occurred in the case of any given cable or system. And Sir John Pender's position might, perhaps, better be described, omitting epigram, as that of one enjoying advantages, taken up in confidence, that priority would give lengthened security against competition; *restrained, to some extent, from despotism*, or from misuse of those advantages by a knowledge that despotism, creating necessity, would at once create competition; and still protected from that competition by the fear of failure in would-be competitors, whether individuals or Governments. This fear it is that keeps up tariffs; the fear that the traffic would not increase in proportion to the reductions made; and the same fear prevents the laying of competitive cables.

If Sir John Pender, which is equivalent to saying, "if the companies" believed the traffic would increase at lower rates, they would adopt lower rates in their own interest and for their own emolument.

Mr. Heaton advocates the further guaranteeing of reductions of receipts on greatly lowered rates—rates lowered to 1d. per word for Europe, 6d. for India, and 1s. for Australia—or if the companies would not accept such arrangements, the laying down by the Imperial and Colonial Governments of alternative cables.

A moment's reflection will show that on either of these methods it is the Governments which would take the risk of loss on the reduction.

Mr. Heaton says:—"As a matter of fact, the cable that girdles the earth is of no more use to the masses of the Queen's subjects than it would be if they resided on another planet, and the explanation is, that a prohibitive tariff is enforced."

Certainly, if the tariffs of 1d., 6d., and 1s. were adopted, the people who have occasion for the cables would use them more; and greatly more people in number would find they had occasion for them. Yet only those at either end, having interests or connections at the other end, *could* find occasion.

And it is now that Mr. Heaton's imperialism and width of view come into play; since, in the last passage quoted, Mr. Heaton loses sight of the indirect benefits that "the masses of the Queen's subjects" derive from cable communication.

It is not only those who use the cable who are benefited by the use of it—for in many indirect ways, in increased security of defence, in increased protection from storms, in increased comfort of daily life by the lowered prices, that result from healthy competition in trade, and the facilitated watchfulness and activity of commerce all members of a community benefit to some extent. Still, neither equity nor morality can call upon those thus indirectly benefited, who do not use the cable, to pay more than the value of the benefits they actually receive, or to pay any proportion of the value of the direct use which others enjoy, or, at most, their share of the possible mental comfort of knowing that a means of communication exists should occasion arise. And the proposition remains that subsidies or guarantees are, or may be, a fair and proper employment of general revenue raised by taxation to secure necessary telegraphic supplies of important political intelligence, or of news of general and public interest, or that security which such means of communication afford, whilst private communications should pay such rates as will return their proper share of the outlay incurred. The difficulty is to ascertain this proportion, and to adopt a criterion that will be generally admitted.

The advantage, and even the necessity of securing intelligence are such that, were private telegrams excluded, it would yet be imperative for great kingdoms, such as the United Kingdom and the United States, to afford from public revenue the means of procuring those supplies from all the various parts of the globe to which their far-reaching interests extend themselves. This maxim especially applies to Great Britain, and Mr. Heaton might be admitted to have perfectly good grounds for the indignation he expresses that this great country contributes nothing towards subsidies, if he did not proceed at once to cut away, on the proximal side, the branch on which he sits by showing that so great is the amount of business given by the State to the Australian cables, that the companies take that business at 2s. 7d. per word, against 4s. 9d. for the business of the private individual. Mr. Heaton makes this a charge of meanness against the Government. It is rather, I venture to think, the general custom of all people who do business on a large scale to obtain more advantageous terms in consideration of the high value of their large transactions; and, I suppose, this is the reason the companies in question accept the lower rates; though, on this head, I should be glad of further information. And, possibly, in this method of paying for business actually done we have the criterion of which we are in search as to the proportion of whole cost to be borne respectively by public and by private business in this and some other respects.

Mr. Heaton's article, and the facts and conditions and general experience of telegraphy in the East are, I find, of great importance, and will very materially aid in arriving at correct views of the conditions existing in the West Indies; and I shall therefore complete as briefly as possible in my next, my review of that article from the peculiar standpoint that experience in the West Indies affords. And if I have examined critically some of Mr. Heaton's positions, it is that I am deeply interested in his object—cheap and easy communication; and feel sure it will be most speedily attained by the utmost moderation; and that anything like over statement will tend to cause delay.

The situation, and the necessity for an accurate and careful appreciation of the position, is, to me, the more necessary because, owing to the offers now made by the Halifax and Bermuda Cable Company to extend their lines to Jamaica, there may be a possibility that the element of competition may be imported into West Indian telegraphy, and the conditions become more nearly like those of the East.

I have, meanwhile, made all the enquiries possible to ascertain the necessary data, as to the West Indies, and I have to acknowledge invaluable help, in the shape of information, both from the West India and Panama Telegraph Company, and from the Halifax and Bermuda Cable Company. Naturally the two companies take very different views of the situation, and each holds those views strongly. To me it is rather gratifying to find that the West India and Panama Company is so willing to afford much of the information they have given me, than surprising to find that some is withheld or stated as unimportant.

This opportunity is a question of supreme importance for the West Indies; and the spirit in which it is dealt with, will for many years to come have, for good or for evil, a great effect upon their interests.

I am rather puzzled as to the attitude of the West India Committee on the subject. Their circular of April, 1893, appears to manifest a very strong interest in securing reduced rates, and no slight feeling against certain obstacles to accommodation between the West India and Panama Company and the Halifax and Bermuda Company, said to exist in the form of "rigid" conditions in contracts with other companies; whilst their last circular, of May 22nd, appears to some extent to maintain that such conditions exist in fact, and are binding and valid. I am informed that the Panama Company are not without influence with the West India Committee, but certainly the true interests of the West India Committee and of West Indian colonists in this matter are identical, and I trust in my next I may be able to elucidate the position.

ELECTRICAL NOTATION.

NOMENCLATURE is nothing if it is not clear, and therefore in establishing or extending a system every care should be taken to ensure a concise arrangement of definitions and terms. The growth of technical notation in any art or science takes place side by side with the development of its theory and practice; and may be regarded as a fair measure of the extent to which knowledge in that direction has

increased. On the other hand it might be said that a science has lost its primitive keenness when all its functions have been defined, and all its characteristics are known. This can never be quite true, because of the limitlessness of nature; but, at the same time, the rise and fall in the popularity of various phases of science is marked by the ebb and flow of our exact knowledge concerning it. Thus astronomy might lose in interest if we could count the number of the stars. History becomes a mere flat record if there is no doubt of the dates. Humanity, in uncertain instances, has lost all enchantment when we hear whispers of its age. Who knows then, what will happen to electricity when the Chicago Congress has reduced all its electrical eccentricities to figures?

We have already alluded to the work which lies before this congress. The provisional programme is now in print. Their first attempt will probably be in the direction indicated by M. Hospitalier, to establish a clear and precise distinction between a *physical quantity*, its *magnitude* or *value*, and the *unit* for measuring such a quantity. In addition, he suggests a uniform system of reference to articles in technical periodicals, advising that, in every case, the *volume*, the *page*, the *date*, and the year should be stated. There will be some skirmishing as to the names to be given to the new units required for magnetomotive force, reluctivity, reluctance, &c. The "Weber," to which we were introduced years ago, will now in all probability be heard with a new meaning, and a Sam Weller pronunciation. The "Gilbert" and the "Sullivan" (?) may yet come to terms at this universal christening. A discussion is to be expected in determining whether the unit of magnetomotive force shall be $\frac{1}{4\pi}$ of an ampère turn, or whether the whole ampère turn is to be taken as a measure of that quantity. Those who are interested in this "4π" discussion should read an article by Mr. J. R. Rosebrugh in the *Electrical World*, Vol. xxi., No. 19, May 13th, 1893 (Congress please notice that we give our references in full).

In looking down the table of symbols and abbreviations which has been drawn up by the Committee, a few points seem to strike us as being capable of improvement in the choices they have made. To begin with, we should submit, that no single physical quantity should be assigned two symbols, in an explicit system, which proposes to give a fixed symbol to each quantity. This applies to Length (L, l); Resistance (R, r); Time (T, t); one symbol is enough in each case. Secondly, we do not see the appropriateness of the pretty symbols: 𝔐, 𝔊, 𝔇, they look very charming in picture-books, but they take too long to write for calculations. Every electrician has now to learn Greek, if he wishes to feel at home at any angle; there is no objection to this, but we hope we shall not have to study antique German and English characters for the simple purpose of an algebraical expression. The American electricians are wanting to express the fundamental equation as $I = E : R$, at which we expect every English electrician to grumble. To begin with, the first person singular is here sadly out of place, and should never be allowed to express current. In a written MS., it might easily be mistaken for the numeral "1"; besides which, it stands as a relic of "intensity," a vagary which is slowly dying. If used at all, it should be the symbol for moment of inertia, instead of K, which takes that position in the American list. With these simple changes we can return to our classic expression, $C = \frac{E}{R}$, and forget that "intensity" ever had an existence, and K would take its time-honoured meaning, as capacity, instead of C. An alteration is put forward by the provisional programme with regard to the sign of division in an algebraical fraction. There is an evident wish to fall away from the horizontal bar; and the suggestion is made that a colon (:) should fill its place—another indication that American electricians are sinking into a dotage. The objection to the colon is that it has a distinct meaning of its own in ordinary written and printed matter, and although it has been used to represent proportionalities, we are not exactly familiar with it, as things go. The grocers obliquity (/) is a little improvement, but really the question is scarcely worth wasting time about. The committee evidently cannot decide whether to spell metre "meter," or meter "metre." They use sometimes the one form and sometimes the other. In justice to France it is to be hoped that there will be no more "meters" among the units. Our suggestion is to retain "metre" for terminal syllables of the metric system, and to use "meter" to express recording and measuring instruments.

CHARGE OF CONSPIRACY AND THEFT AGAINST THE GENERAL ELECTRIC COMPANY, U.S.A.

THE giant combinations representing electrical interests in the United States have, as is well known, long sought to obtain advantage over each other by means of open legal war with patent rights. Unfortunately, open and fair means do not appear to have been the only methods that have been used in the desire to obtain supremacy. The Westinghouse Company has lately brought charges of a very grave nature against the General Electric Company. That the matter is sufficiently serious is evidenced by the fact that no less than four persons connected with the General Company have already been arrested, and orders for the arrest of five more have been issued, amongst the latter being Charles A. Coffin, president of the accused company. It appears that a young draughtsman of the name of Frank Carey has, seemingly, been attempting the impossible feat of consistently serving rival masters at one and the same time. This enterprising young man was formerly in the employ of the Thomson-Houston Company, and in July last he became engaged by the Westinghouse Company. It is asserted by the latter company that all the time that Carey was in its employ at a certain salary, he was receiving a much larger salary from the General Company, and, amongst other things, he occupied himself with disclosing the company's secrets, and stealing certain drawings and documents for the benefit of his other employers. Further, that he had a large corruption fund placed at his disposal wherewith the better to carry on his treasonable transactions, and that all his arrangements were made directly with President Coffin and W. J. Clark. The drawings, numbering about 180 in all, relate principally to various descriptions of electric railway plant, dynamos, transformers, and such like apparatus. The charges of conspiracy and theft have been denied by the accused *in toto*, though Mr. Clark has admitted that Westinghouse drawings have been in his possession He expressed the opinion, however, that plans and drawings are never regarded as private property. It is almost needless to say that a bill in equity has been filed against the General Company, and also against several of the officers individually. Those persons already arrested, when attending the preliminary hearing, all preferred to await a Court trial, which will take place early this month. The accused have been released on bail in amounts varying from $500 to $2,000. The retort made by the officials of the General Company is that the object the Westinghouse Company has in view in bringing these charges, which are asserted to be malicious and false, is to depress the company's financial position in the stock market. We must await the regular hearing for full truth in this matter.

AYRTON AND MATHER'S ELECTROSTATIC VOLTMETER.

FOR the last three or four years Prof. Ayrton, in conjunction with Mr. Mather, has been experimenting with a view to the construction of a trustworthy and accurate electrostatic voltmeter for the measurement of high pressure. There can be no question about the great advantage of placing an electrostatic voltmeter direct on the high-pressure mains, over the clumsy expedient frequently employed of wasting power in transforming down the pressure to suit the range of a low pressure hot wire voltmeter, which can only give a reading by wasting a great deal more power.

An increasing need is, therefore, felt for an electrostatic instrument prompt and accurate in its indications, and safe both from liability to internal injury caused by the pressure it measures and from risks of causing dangerous shocks to persons handling the instrument when in use. To fulfil the requirements of the engineer it should also have a bold scale, be suitable in form for fixing on a switchboard, and be quite unaffected by the cleaning of the glass, or the proximity of other bodies, whether electrified or not.

FIG. 1.

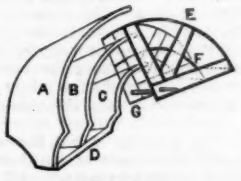


FIG. 2.

Many instruments were constructed by the inventors, some with spring or torsional control, others controlled by gravity; after exhaustive tests the style of instrument which fulfilled the conditions best was selected, and in its final form it is shown in fig. 1.

The working parts of the instrument are shown diagrammatically in fig. 2, in which the parts A, B, C are the fixed inductors, correspond-

ing to the quadrants of an electrometer. These inductors are curved brass plates whose edges and corners are carefully rounded to prevent sparking. They are connected together by the plate, D, and fixed in an inner case, from which they are highly insulated. The needle, E, F, consists of two thin curved aluminium plates concentric with the staff, G, which carries them. These plates are drawn into the space between the inductors by the electrostatic attraction between them. Being curved, they have the advantage over flat plates in strength and lightness, their moment of inertia is small, so that the needle takes its position of equilibrium rapidly, and as the peripheries and spokes of the needle are made out of one piece of aluminium the electric conductivity is perfect, and the voltmeter accurately measures direct or alternating the pressures of any frequency. The needle is counterpoised by the hand and controlled by a weight attached to an arm on the staff so as to bring the hand to zero; it is finely pivoted in jewels, and works in a frame attached to the circular brass plate seen near the top of the dial. The working parts can thus be easily removed bodily. The needle is in connection with the dial, which carries the inner case containing the inductors, the latter being highly insulated. From the inductors an insulated spring reaches downwards alongside a similar spring attached to the inner case; these springs make contact with the terminals.

The dial is supported on ebonite pillars and surrounded by a bezil ring of ebonite, which prevents contact with the outer case, the latter is therefore entirely insulated from the circuit.

Each terminal, of which a section is shown in fig. 3, is cased in ebonite, so that a person connecting up cannot receive shock from it. The hollow ebonite portion, A, A, contains a brass block, E, im-

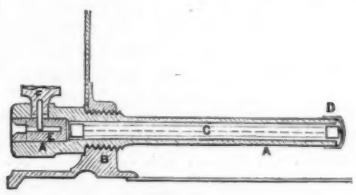


FIG. 3.

bedded near its outer end and covered by an ebonite nipple: the block is tapped for the set screw, F, which holds the wire in place. The part of A which projects into the case, into which it screws at B, contains a fuse of platinum-silver, ·001 inches diameter, enclosed in a glass tube with metal caps to which it is connected. They make contact with the block, E, at one end and the spring cap, D, at the other. The cap, D, makes contact in turn with the connecting spring mentioned above. The fuses are therefore very easily replaced.

To enable the instrument to be easily disconnected from the mains when necessary, a switch is provided; the handle seen on the left side of the instrument is attached to a cam-shaft and turning it down raises the springs from the caps, D, of the terminals, and so disconnects the instrument from the mains; it then short-circuits the inductors and needle, bringing them to the same potential.

A spark gap is arranged inside the voltmeter; before the instrument is sent out it is tested at considerably above the working pressure for sparking between the needle and inductors, the gap is then adjusted, so that, in case of abnormal rise of pressure, sparking will occur at the gap and produce no damage.

A device is provided whereby the engineer may see at a glance whether the working pressure is being maintained; it consists of an index below the scale (seen to the right of fig. 1) adjustable by a crown wheel and pinion at the top of the instrument. It can be thus seen at a distance whether the pressure is right, that is whether the hand and index coincide. Then the index is turned as far as it will go to the left it clamps the needle for travelling.

The scale has a radius of 6 inches and a length of 10 inches, thus giving a bold open scale whose clearness is enhanced by the dead white silver of the dial. The external diameter of the instrument is 12 inches.

The instruments at present made are suitable for circuits at 500, 1,000, 2,000, and 2,400 volts, the range being very open near the working pressure. By differently shaping the inductors an equally divided scale may be obtained when desired.

The instruments are made by Mr. Paul, 44, Hatton Garden, and Leather Lane, London, E.C.

FINANCIAL CONDITION OF THE GENERAL ELECTRIC COMPANY, U.S.A.

In spite of the considerable net profit of $3,356,593.10 officially declared to have been made by this company during the past year (see our issue for May 12th), the market value of the stock has been declining very appreciably of late. Financial manipulations in the past with several of the individual companies out of which the General Company has evolved, have been frequent and varied, with the result that the capital has been enormously watered—some say to the extent of 80 per cent. Strenuous efforts to bolster up the market have been made by President Coffin and others, who maintained that the stock was a sound 8 per cent. investment, and would rise to a premium of 50 per cent. on its par value. These efforts succeeded at one time in running the market price up to 119, but a steady decline has since set in, and a short time ago it had fallen to 58. Several causes have assisted in bringing about this decline, the most prominent among them being, doubtless, the late legal defeat by the Columbia Company, the accusations of the Westinghouse Company, and a pertinacious attack on the company's finances by several electrical and other journals. That there *may* be serious ground for fear that the concern is, or has been, in a somewhat straightened condition may be gathered by an admission that has been made by President Coffin. A director of the General Company recently wrote to him asking a number of questions relative to the company's financial affairs, and amongst these was the following:—"Has the company at any time this year been disturbed in any of its loans, or been in any instances refused such accommodation as it has desired, or in any instance failed to meet all obligations promptly?"

In reply, it was admitted that all obligations had *not* been promptly met, and that the company *had* been disturbed in respect to its loans. To other insignificant questions, however, such as whether the issue of more stock was contemplated, whether unusual loan accommodation had been sought lately, whether the company was in an easy financial condition at present, whether the stock could be recommended as a safe 8 per cent. investment, and so forth, the answers given were all favourable to the company's sound position. Mr. Coffin proceeded to say that it has been asserted, by those who are attacking the company's reputation, that payment for goods sold is largely taken in stocks and bonds. To meet this a statement was about to be published in the financial papers to the effect that $3,000,000 of railway orders were now on hand, the entire amount of which is sold for about 80 per cent. cash, and 20 per cent. secured notes, with no obligation to take stocks or bonds for any part thereof. The sales of lighting apparatus are also almost exclusively for cash or well secured notes. It is too early yet to ascertain what the intrinsic value of the stock really is; but it would appear from the circumstance that obligations have not always been promptly met, that much of the splendid net profit of three million or more dollars must consist of paper in an intangible form. At best the security seems speculative, and speculators in it will do well to limit their investments to such amounts as they can conveniently afford to lose.

AUSTRALIAN ELECTRICAL NEWS.

[FROM OUR OWN CORRESPONDENT.]

NEW ZEALAND seems to have set a good example to all the other Australasian colonies with regard to financial matters, and appears now to be in a fair way to do the same in electrical matters, as we are continually hearing of something electrical from there. The plant for electrically lighting the streets of Wellington appears to have met with so much favour, that active operations are being carried on with regard to the extension of the central station to admit of private lighting being undertaken. The street lighting was by means of 32 and 50 candle-power incandescent lamps run from transformers in parallel. In connection with this, what may be termed a very peculiar accident occurred in Wellington a short time ago, by which a youth received a severe, but fortunately, not a dangerous injury. It was one of those accidents in which electricity receives all the blame, while being responsible for only a portion of the damage done. The youth in question was riding on the top of a tram, and it was after dark and the electric lamps were alight. It appears to be a sort of amusement among the lads of the district to try and reach the electric light wires which are suspended rather low; the youth in this case seized one of the main conductors, and having succeeded in doing so, presumably to his own satisfaction, discovered on attempting to let go again, that the wire had conceived a strong attraction for him and refused to release him. He was first dragged the length of the tram-car, the tram being on the move at the time, the driver being unconscious of the tragedy that was being enacted over his head; by the time he had just about reached the end of the car, his companions awoke to the fact that unless they acted promptly there might be a serious accident, so they seized the unfortunate youth to prevent his being dragged bodily off the car with a strong presumption of a fall into the street afterwards. After some difficulty his hand was disengaged from the wire, but not until after it was much lacerated and rather severely burnt. A local paper in describing the incident makes the following curious comment:—"It would seem that these electric light wires are not insulated, as is the case with the telegraph wires. When the lights are turned off in the day there is no danger."

The new station which is being constructed under the supervision of Mr. A. J. Suckling Baron, will be arranged for a maximum supply of about 5,000 16-candle-power incandescent lamps. A fine brick building has been erected to contain the plant, which comprises boilers and horizontal engines by Davey, Paxman & Co., and Gülcher alternators of Esson's design, of the same general type as the Westinghouse. The switchboard is also very similar in design to the Westinghouse pattern. The cables are Callender's Australian pattern, especially designed to stand the heat of the Southern summer. Judging from the present condition of thing, this should be a very successful venture, as of the total of 5,000 lamps some 2,000 odd have already been applied for, a fact which, considering the station will hardly be able to start before June next, points to the possibility of an extension being required at no very far distant date.

Mr. Baron is also putting in a precisely similar plant at Christchurch in the South Island, this also will be purely for private lighting, as the Gas Company's contract has just been renewed for a further term of seven years at a reduced rate.

New Zealanders, too, are gradually awakening to the fact that they have a considerable amount of power going to waste in their numerous waterfalls, which are well distributed throughout the colony, but which at present are only picturesque. As long as six years ago, a

Brush plant was put in on the Phœnix Gold Mine, at Skipper's Creek, consisting of two 65-light dynamos, driven by two 6-feet Pelton wheels, running at 160 revolutions per minute under a head of 165 feet. These give a full load of 20 ampères at 2,000 volts, or about 54 H.P., which is conveyed nearly two miles, by four No. 8 B.W.G. bare copper wires to the Victoria dynamo that serves as a motor, driving the stamping battery at 80 blows a minute, and working also the air compressor and a stone-breaker. The plant is still successfully working, and about two years ago an adjacent mine adopted a similar plant of about 50 H.P. for working a bucket dredge which is used to scoop up the bed of the river, which is carefully washed in the approved fashion for the purpose of sorting out the grains of gold which are found mixed with the river sand. Apropos of this a recent letter from Wellington says that the low grade of the Kuaotunu ores and the great cost of taking coal on to the field have very seriously retarded its progress. Representations have been made to the Government that there is about eight miles from Kuaotunu a large waterfall in such a situation that electricity generated with it might be conveyed to the field and used as a motive power, doing away with the necessity of hauling coal or wood, and by very greatly cheapening the cost of treating the ore, assure the success of the field. The Government have decided to send up Mr. Fletcher, of Otago, who has executed similar works in Westland and the south, amongst them being the Sandhill dredging plant mentioned above. Mr. Fletcher will be accompanied by Mr. Gordon, chief inspector of mines, and they will see what can be done in the matter. The same letter states that the directors of the Wellington Gas Company have resolved to amend their memorandum of association to give them power to supply electric light to those requiring it. They consider that when the loss of distributing the supply from a central station is taken into account that they will be able to supply their customers in a much more satisfactory manner and at less cost by a separate installation than from any other source. It does not appear quite clear how they intend working this arrangement; but if they merely supply and erect the plant and allow their customers to work it, or whether they put in the plant and work it themselves and charge their customers an annual rental for the use of it, they will probably find, with the rival central electric light station at work, that it will not pay them quite so well as they seem to expect. In all probability the scheme will be amended before being actually put into operation, if not there is a strong presumption that the shareholders will not receive such nice large dividends as they have been in the habit of receiving. The only comment one can make on this is "time will show."

LEGAL.

CORPORATION OF LONDON *v.* THE CITY OF LONDON ELECTRIC LIGHT COMPANY.

IN the Chancery Division of the High Court on Friday last, before Mr. Justice Stirling, Mr. Graham Hastings, Q.C., moved, in an action in which the Corporation of London as the masters, guardians, and governors of Bethlehem's Hospital are the plaintiffs, and the City of London Electric Light Company are defendants, for an injunction against the defendants to restrain them from breaking up, excavating, or otherwise interfering with Lime Street Square in the City of London. He said the Square was the property of the plaintiffs, and had belonged to them for 200 years, according to the records in the possession of the Corporation. It only on Thursday came to their knowledge that the defendants were breaking up the Square and forming a vault under it as a converting chamber, which was 30 feet long, 10 feet wide, and of a great depth. The defendants had not obtained any authority from the plaintiffs for so doing, and they were going on doing it.

Mr. EVE said that the writ was served only on Thursday night upon the plaintiffs, and received that (Friday) morning. Their defence was that they were acting under statutory powers; but he must ask time to answer the plaintiff's case.

His LORDSHIP: Well, you must not do anything more in the meantime.

Mr. EVE undertook that nothing further should be done in the meantime, and thereupon the motion was ordered to stand over for a week.

LEVY *v.* ELECTRICAL WONDER COMPANY.

IN the Queen's Bench Division on Tuesday last, this case was heard. The plaintiff was formerly the manager of the defendant company, and claimed to recover a year's salary, in lieu of proper notice, alleging that he had been wrongfully dismissed. Plaintiff was—according to a minute in the company's books—appointed at a salary of £5 a week and 5 per cent. commission on the net profits, and the defendants, in terminating the service of the plaintiff, only gave him a week's notice. The plaintiff, however, contended that he was entitled to a year's notice. During the hearing of the case the learned Judge held that the minute was inconsistent with a contract under which defendants could give a week's notice, and, therefore, the only question for the jury was what was a reasonable notice. The jury gave a verdict for the plaintiff with £30 damages.

Edinburgh Electric Lighting.—Prof. Kennedy has been appointed engineer to the Corporation of Edinburgh in connection with the installation of electric light which the Council propose to introduce into the city.

NOTES.

Royal Society Conversazione.—The summer *conversazione* of this society was held at Burlington House on Wednesday evening. Lord and Lady Kelvin received the guests.

Coast Communication.—A Dalziel telegram, dated New York, June 2nd, which appeared in the daily papers, reads as follows:—"Sir Edward Birkbeck, chairman of the National Lifeboat Institution and a member of the Royal Commission on Coast Communications, visited Ottawa on May 19th, in order to enquire into the Canadian system of electrical communications on the coast for life-saving and other purposes. In a statement to-day, he gave an account of the result of his enquiries in Canada and the United States. He said that Mr. C. H. Tupper, the Dominion Minister of Marine and Fisheries, described fully what the Government had done and what it intended to do as soon as the necessary appropriations had been made by Parliament in the matter of making the coast communications as perfect as it was possible to make them in order to meet the ever-increasing trade up the Gulf of St. Lawrence during the season of navigation. The Canadian Government courteously placed the steamer *La Canadienne* at Sir E. Birkbeck's disposal, and he proceeded from the coast of New Brunswick to the various life-saving stations on the Gulf of St. Lawrence as far as the island of Anticosti, near which a large number of coasting vessels as well as mail steamers pass from the Straits of Belle Isle. He remarked that it was of great importance that there the cable and coast wires for life-saving and mercantile purposes, and for weather reporting, should be of the most trustworthy character. The coast on the north was high, and without harbours, and on the south low and dangerous. Leaving Canada for the moment, Sir Edward Birkbeck proceeded to say:—'When I arrived in New York the United States Government, at the request of Her Majesty's Government, gave me every facility for a thorough inspection of the life-saving stations and their system of working, as well as of the coast telephonic arrangements generally. Yesterday I inspected the various stations on the coast of New Jersey, and the working of the telephone for life-saving purposes was practically illustrated by one of the officials. Every station within the district I visited, spreading over a coast-line of more than 70 miles, was communicated with by telephone. The wire is carried along the coast from station to station, which is a great improvement compared with the system now being established in England.' Reverting to the Canadian service, Sir Edward Birkbeck said:—'One of the most striking points in connection with the system at present in force on the coast of Canada is that the various lighthouse keepers are all practical telegraphists. It is part of their official duty to telegraph twice every day. reporting not only the facts concerning every vessel signalling her numbers, but also any communication which the captains of the passing ships may wish to have reported in the Canadian newspapers. They send to Toronto twice a day full reports regarding the state of the weather. As far as the lighthouses are concerned, the ordinary telegraphic instruments are in use instead of the telephone. The number of first-class hands employed at the lighthouses is in many cases two, and, at most, three. Therefore, the objection raised in England, that the lighthouse keepers would not be in a position to use the telegraph or the telephone were they provided, falls to the ground.' 'I was very much struck,' added Sir E. Birkbeck, 'by the fact that the United States Government disband the staffs at the life-saving stations from May 1st to September 1st, with the exception of the stations on the Pacific Coast and the Great Lakes. Only one of the officials is kept at each life-saving station during the summer months, but the telephone is still maintained in constant working order, and many commercial and private messages are forwarded throughout the year from the life-saving stations to the nearest telegraph stations for transmission. I purpose concluding my enquiry to-day by a consultation with the principal officials at the office of the life-saving department in New York. The valuable information I have gathered will be reported to the Royal Commission on Coast Communications, of which I am a member.' Sir E. Birkbeck will return to England by the Cunard steamer *Campania*, which sails to-morrow."

Fatal Accident to a Telephone Linesman.—Last Wednesday one of the *employés* of the National Telephone Company, named John Vaughan, while at work at a number of new poles lately erected in Chichester Street, Belfast, fell and was killed.

Chicago Congress.—Prof. Elisha Gray, the Chairman of the World's Electrical Congress Committee, has communicated the following to the *Electrical World* (N.Y.) :—"We have the pleasure to announce that in accordance with the expressed wish of the American branch of the Advisory Council of the World's Congress of Electricians, the Secretary of State has appointed Prof. H. A. Rowland, Johns Hopkins University, Prof. T. C. Mendenhall, Superintendent Standard Weights and Measures, Prof. H. S. Carhart, Michigan University, Prof. Elihu Thomson, Lynn, Mass., and Prof. E. L. Nichols, Cornell University, to sit in the Chamber of Delegates as the duly authorised United States delegates. While there are many electricians in the United States who could fill with dignity and credit to the profession this honourable and responsible position, yet the profession is to be specially congratulated that the United States will be represented by men of such high standing, both as gentlemen and members of the profession. We also have the pleasure to announce that the Royal Commission has named Mr. W. H. Preece, Prof. S. P. Thompson, Prof. W. E. Ayrton, Major Cardew, and Alexander Siemens as delegates from Great Britain. There is every reason to believe that the success of the Congress is now assured, and that all the important countries will be fairly represented."

Sixty Miles an Hour by Electricity.—The San Francisco *Industry* states that the Pullman Company, of Chicago, has given an order to the American Storage Battery Company there for 380 cells specially made for a car to be employed by Mr. Pullman in his journeys to New York. The car is to be driven by an electric motor at a rate of 60 miles an hour, and will perform the journey in 16 hours. Mr. Armstrong, of the Electric Storage Company here, computes that the stored energy will drive such a car for 20 hours, but the charge is not wholly relied upon. There is a supplementary plant for generating that will come into use on grades and curves of much resistance. The batteries employed are of a new form, on the Planté system, in so far as functions or the manner of operating, but of a wholly different construction. The Planté cells required months to charge, while the new form can be charged in 8 hours. This car will be one of the noticeable electrical exhibits at the Chicago Exhibition.

The Sheffield Technical School.—Anyone who happens to be familiar with the works and ways of Sheffield will know that it is not a place where things are done by halves. One of the most flourishing towns in England, it is not likely to take a second place in any great reform having for its end and purpose the improvement of labour and the extension of technical instruction. No wonder, therefore, that the Sheffield Technical School has grown to be one of the finest of the kind throughout the world. Our contemporary, *Industries*, has recently given an account of this institution, from which it appears that attempts were made to establish something of the kind thirty years ago; but it was not till the great educational wave passed over the country, in 1883, that the suggestion was brought to a practicable issue. The School was opened by Sir Frederick Bramwell in February, 1886. Externally it appears as a large but very unpretentious brick building. It contains means for instruction in the greater branches of mechanical engineering as applied to the steel and iron trades, and also the necessary machinery for the illustration of mining and electrical work. Sheffield is very happy in its supporters; for in addition to the help it derives from the world-famed cutlers and the giants of the iron trade, it is very considerably aided in its educational schemes by the Dukes of Norfolk and Devonshire. We look to Sheffield as one of our strongest fighting forces against foreign competitors; it is, perhaps, to Sheffield that we owe the best of our modern reforms in trade marks; "Manufactured in Germany" was forced upon the goods of Allemagne, very justly, by Sheffield cutlers, and we hope that the Technical College will be found very helpful in their great international struggle.

Tramcar Bells.—The Grand Berlin Tramway Company are largely adopting electric bells on their cars. Two bells are arranged on each platform, and six pushes are placed inside the car.

The Engineering Exchange.—We understand that this exchange is now efficiently housed and provided for in every way. A circular that is being distributed announces the reduction of members' subscriptions to £3 3s. per annum. As the general membership now considerably exceeds 1,000, it has been decided that after June 30th an entrance fee of £5 5s. will be imposed on all new members. Applications are to be sent to the secretary at 33, Old Broad Street, E.C.

Hull Electric Lighting.—The question of filling up the vacant office of electrical engineer to the Hull Corporation, consequent on the resignation of Mr. F. Harman Lewis, through his acceptance of a similar post at Wolverhampton, which we announced last week, has been discussed by the Electric Lighting Committee, who have recommended the Corporation to advertise for a new electrical engineer at a salary of £250 per annum.

Tiverton Electric Lighting.—Last week the members of the Tiverton Town Council had under consideration a proposal to introduce the electric light at an estimated cost of £13,740. Objection was taken to the proposal on the ground of the financial condition of the borough, and eventually it was decided to apply to the Board of Trade for an extension of the time for which the provisional order had been obtained.

Early Connection with the Telephone Business.—In some "Reminiscences of Early Telephone Days," in the New York *Electrical Engineer*, Mr. F. E. Kinsman writes: "Early in September, 1877, I was surprised by the receipt of a letter from E. T. Holmes, of Boston, requesting me to enter his service to assist in the introduction of the telephone in that city. The letter stated that he had been led to make this offer in view of the fact that he had learned of my experience in planning the central office system, and believed that this experience would be of some value to him. I accepted his terms and went to Boston, and in company with another of his *employés* there, constructed what I believe to have been the first 'central office' telephone system ever built. I was sent to Chicago to assist the American District Telegraph Company in establishing their Chicago telephone business, under the auspices of the Western Union Telegraph Company. I believe it was here that the district telegraph boxes were first regularly used to signal for a communication on the telephone line, *the call boxes and telephones being on separate circuits.*"

The Bonus System and Profit Sharing.—The *Journal of Gaslighting* has fallen foul of a recent article in which we described the bonus system initiated by the Westminster Electric Supply Company. It is stated that no information is given as to how this allowance is expected to work out. On this point we shall be very glad to enlighten our contemporary, and to supplement what we previously said by adding that the net result will very probably be to increase the wages of the *employé* by about 6d. in the pound. This is, to all intents and purposes, a proportion of the profits of the company paid to those by whose efforts the business is maintained. The contention that profit sharing as practised by the South Metropolitan Gas Company is a proposition of an entirely different kind seems to be a mere badinage of words. In degree, but not in kind, there exists a difference which is readily appreciated at its true value, and we fail to see the benefit to be derived from a metaphorical hair splitting as to terms. Profit sharing may be applied over all the operations involved, or only in that branch in which sensible benefit is derived, and because it seems best to those in authority to follow the latter course, the co-relation of ideas remains unaltered. To correctly appraise the value of any such economic factor requires a close acquaintance with the details of the business to which it is applied, and it must be remembered that in electricity supply the two principal items of cost are coal and distribution expenses, which are independent of each other, while to these management has to be added, which in itself is an outside question.

City of London Electric Lighting Bill.—The Bill recently introduced into the House of Commons by the City of London Electric Lighting Company was on Tuesday last passed as an unopposed Bill by the Chairman of Ways and Means.

A Good Offer Refused.—The *City Press* states that Sir Edward Watkin, M.P., who has a seat near Beddgelert, has offered to provide the Welsh Methodist Chapel at Bethania, Cwmllan, with the electric light free of charge, but it is said "the simple folk are rather timid of adopting the experiment."

Factory Acts.—Messrs. Emile Garcke and J. M. Fells have had reprinted from the fourth edition of the *Factory Accounts* their "Summary of the Factory and Workshop Acts" for the use of manufacturers and managers. The pamphlet (which consists of 40 pages) is prepared in very convenient form, and all points in the Factory Acts are placed at the reader's finger ends for easy reference.

Sunderland Electric Lighting.—Prof. Kennedy, in his report to the Town Council states that a portion of some land now in their possession will be very suitable for a central station. He estimates that 5,600 lamps will be required by the inhabitants. The generating plant he considers will cost £17,500, while an additional £3,500 would enable them to supply the electric light to the shipyards and docks.

"Electro-Hygiene."—This is a new monthly journal devoted to electricity in relation to health and disease, edited by H. Newman Lawrence, M.I.E.E. In alluding to its programme, our newly-launched contemporary says:—"Every new journal either supplies a want, or thinks that it does. We lay no claim to exception from this rule." The first article, "The Truth about Electric Belts," and another, "The Hypnotysed Mummy," should be spread broadcast throughout the whole kingdom, and *Electro-Hygiene* would at once fill a real want. We wish it every success.

Omnibus Accident.—A turner named Palmer, who had been in the employ of the Telegraph Construction and Maintenance Company for 16 years, has secured £93 10s. damages from the London General Omnibus Company for injuries received while travelling on the front seat of an omnibus. Through faulty driving, plaintiff's head came into collision with a pillar lamp erected near the kerb at the corner of Tottenham Court Road.

Curious Experiment.—According to M. D. Hurmuzescu, if an electric current be sent through a platinum wire stretched between two supports, the current being strong enough to bring it to a red heat, then if one of the supports be moved so as to increase the tension on the wire, the latter will commence to vibrate in a vertical plane, this oscillation being slow at first, and then becoming more and more rapid. Nodes can be produced in the wire, and it is found that the amplitude of the vibrations is different in different gases, the tension on the wire and the current passing being kept constant; it is seven times as great in hydrogen as in air, whilst in carbonic anhydride no vibrations are set up.

Bradford Electric Lighting.—The Electricity Committee of the Bradford Corporation have had under discussion a scheme devised by Mr. Baines, the resident engineer, by which he proposes to substitute the present two-wire system by the three-wire system, and also to extend the electric light a considerable distance up Manchester Road, the total cost of all the work being between £5,000 and £6,000. We commented favourably upon Mr. Baines's scheme some weeks ago, and thought the council would do wisely in adopting it. Not to be outdone, however, Mr. Shoolbred comes forward with a five-wire system in substitution of the present two-wire. The committee, after hearing Mr. Shoolbred's explanation, debated as to which scheme should be adopted; but eventually decided to adjourn the matter, and leave to a sub-committee the advisability of calling Lord Kelvin to advise the committee as to what was best to be done. There is little doubt in our minds as to the advice Lord Kelvin will give.

Cable Communications.—The following are the interruptions to cables which have occurred during the past week:—Shanghai-Amoy cable interrupted June 5th, 1893; Hong Kong-Foochow cable, ditto, June 5th, 1893.

Electrocution.—On the 6th inst., states a New York telegram, an Italian named Martella, who murdered a compatriot, was executed by electricity at Clinton Prison, Dacemora. Two contacts were necessary, the first shock not proving fatal.

Bolton Electric Lighting.—The final report of the Electric Lighting Committee is now completed. A second visit has been paid to Oxford, so that the newly elected engineer could see the installation there. It is expected that the town authorities will be in a position to supply the light during next winter.

Electric Traction in Charlottenburg.—As the concession for the Berlin-Charlottenburg tramway expires shortly, and as the present horse cars have proved inadequate for the traffic, the Charlottenburg magistrate recently informed the company that the concession would only be renewed on condition that electricity was used as the power. The concession is now to be renewed for 40 years, and Messrs. Siemens and Halske are to equip the line electrically.

Lancaster and the Electric Light.—The Lancaster Corporation having settled their differences with the Brush Electric Lighting Company, will commence the necessary works for the electric light installation when the borrowing of the money required has been sanctioned by the Local Government Board. It is proposed to appoint a resident engineer under the direction of the Borough surveyor, the commencing salary being fixed at £120 per annum.

The Hanover Electric Railway.—On May 20th the electric railway at Hanover, constructed by the firm Siemens and Halske, was set in action with 13 carriages, which all work in a satisfactory manner. At the opening special attention was drawn to the steadiness of the motors and the simplicity of the above-ground system of supplying current. The electric working is hitherto limited to two lines:—1. Königswörth Place to Herrenhausen Stöcken. 2. Linden to Sinner, on which there travel in all 18 motor cars and also extra cars. The generating station is at present capable of developing 500 H.P., but it can be increased on the projected completion of the lines.

New Journals.—The *Electrical Magazine*, an illustrated popular monthly, professing devotion to "electricity and its mechanical auxiliaries," has been recently started in Washington, D.C. The May issue contains much, from the pen of many writers, of an interesting nature regarding electrical matters in America. Interviewing is the reigning order, in this age of journalism, and the editor of our new contemporary has adopted this popular system, by interviewing Nikola Tesla, and contributing to the present number a long, well written, and interesting account of what passed between himself and that gentleman, who disclosed the nature of some of his early inclinations and experiences. The magazine is of similar size to, and is got up somewhat on the lines of, the *Engineering Magazine* and like publications, and is composed entirely of very readable articles and papers by various authors.

The *Canadian Engineer* is the title of another monthly journal that was last month commenced at Toronto. Its chief reason for existence is asserted to be to supplement the engineering papers of the world, by one containing Canadian engineering information. Descriptions of electrical machinery and notes on electrical matters occupy a fair proportion of space, and all the general departments of engineering are dealt with according to their merits. A policy that has been adopted by the proprietors of the journal might well be imitated by many London trade journals and daily newspapers, *i.e.*, no reader will ever be cheated by advertisements, as at the risk of losing revenue, only reputable firms will be allowed to advertise.

Electric Light in Paris.—Two new pavilions just added to the Cochin Hospital in Paris have been named after M. Pasteur and Sir Joseph Lister; the lighting is effected by means of electric lamps having double glasses.

Electric Light at the Foreign Office.—On Saturday night last, for the first time, the electric light was used at the Foreign Office, Lord Rosebery having had it specially installed in view of the Birthday Reception.

Blackburn Electric Lighting.—The Local Government Board have sanctioned the borrowing of £50,000 by the Town Council for electric lighting purposes. The Borough Engineer and Mr. Barton have been instructed to prepare specifications and working drawings, enabling the Corporation to obtain tenders for carrying out the work.

The Berlin Elevated Railway.—It was reported on good authority in Berlin, on Saturday, although official intimation had not then been conveyed to Messrs. Siemens and Halske, that the Emperor had given his consent to the construction of the projected high-level electric railway. It will be remembered that the Twelve Apostles authorities objected to the line passing the Luther Church, and their objections were upheld by the Minister of Worship. The scheme then came before the Ministerial Council, and was approved and referred to the Emperor, whose permission is said to have been given. The railway is to connect the eastern and western portions of Berlin with branches in other directions. The consent of the Berlin local authorities is now only needed to proceed with the work, which would be completed in two years.

Telephones in Manchester.—A report has been prepared by the Paving, &c., Committee of the City Council, regarding an application of the National Telephone Company to place wires under certain streets of the city. It appears that the company have decided to remove their exchange to a more central position, and are intending reconstructing and re-arranging an extensive portion of their system, with a view to insuring to Manchester greater efficiency in its telephone service. This work is in progress, and the question for the determination of the Corporation is whether they would prefer a large proportion of the wires in the central parts of the city being placed underground, and will give facilities for that to be done, or whether they would prefer that the company should proceed as heretofore by means of overhead wires. If the company's suggestions are accepted, three-fourths of the wires which are at present overhead in the central parts of the city will be removed and placed underground.

Telegraphs in Persia.—Telegraphs in Persia are of a primitive character, and the delay in the transmission of messages is often exasperating. The line worked by the Persian Government between Enjelli and Resht, and thence on to Teheran, works fairly well in dry weather, but in damp or rainy weather cannot be depended upon. The reason of this, says the *Engineer*, is that the insulators are sometimes driven into large trees that have branches growing round the hooks and touch the wire, thus intercepting the current. When large trees are not available, small ones are resorted to, which often break, or, being shaken by the wind, or through the trees being shaken by the wind, the insulator, or the hook upon which it is fixed, becomes dislodged, and the wire trails on the ground. The wire has often been seen lying across the high roads, both in Astrabad and Ghilan, endangering the lives of animals and their riders. The British Consul at Resht observes:—"Under these conditions it is not to be wondered at that telegrams in this country are not received as punctually as in Europe, and gives an instance of a telegram being sent from Europe to Teheran, announcing the sender's intended arrival at Resht in a fortnight. The telegram was received the same day at Teheran by the European line, and immediately despatched to Resht by the Persian line. The telegram was received in the sender's presence 18 days after its dispatch." All messages are received on the instrument "by ear," and no "tape" is kept. The consequence is that mistakes almost always occur when the message is in cypher, or when figures or foreign names or words are sent.

Aluminium.—The Neuhausen Aluminium Company made a net profit last year of £16,370, and is distributing a dividend on the paid-up capital of 8 per cent. The report mentions that since 1890 the price of the metal has fallen from 27s. 7d. per kilogramme to 5s. per kilogramme, and that, on the other hand, the sales increased fourfold. A greater demand is to be met by the acquisition of other waterfalls.

Exhibition in Paris, 1893.—The Société Nationale des Sciences et des Arts Industriels are arranging for an exhibition from July to October this year of all branches of trade. The electrical industries form the 8th group, which is divided into two classes, *i.e.*, Class 20, comprising generating machines, electric lighting, batteries, motors, accumulators, and various other apparatus. Class 21 will include exhibits of telegraphic and telephonic apparatus, cables, electric bells, and numerous other accessories.

Cooking and Heating by Electricity.—A correspondent writes:—"I note you refer to other operations than water boiling where the specific heat is 'considerably under unity.' There is no such case in cooking. All food either contains a very large quantity of water (70 to 80 per cent.), or if it does not, water is added in cooking, and therefore water heating may be safely taken in all cases as a comparative standard, and the cost of other cooking operations will all come out in the same proportion *under the same conditions*. The experts in electrical heating are contradicting each other quite sufficiently and I do not wish to add to the storm in the teapot."

An Instructive Comparison.—An interesting enquiry has recently been made by W. W. Reese and Archibald Anthon into the cost of the electric lighting of Columbia College, New York, U.S.A., by separate plant and by contract with companies. The comparison shows that in a large building where boilers, engines and engineers are indispensable for heating, pumping, the running of lifts, &c., the electric light furnished by dynamos run from the same boilers is very economical. This has been believed in a general way for a number of years; but exactly how much money is saved, by having private plant, over what it would cost if the lamps were fed by currents supplied from some central station electric lighting company, is a problem which few persons have taken the trouble to solve. For several years a portion of the buildings of Columbia College has been lighted by electricity, and during the last two years almost exclusively by its own plant. It appeared that a comparison of what it cost the college for its electric lighting for a certain number of "lamp hours" before it used its own plant with what it now costs for the same number of lights, would be valuable, since the conditions in almost any large building, hotel, club, &c., are very similar to those in the case in question. The plant in the Columbia College consists, briefly, of two steam engines (one by Armington and Sims, and the other a "straight-line" engine by J. E. Sweet, both rated at 36 horse-power), two dynamos of the Edison type, both 400-light machines, with the necessary conductors, switchboard, lamps, instruments, &c. By an inspection of the company's bills for previous years, and the records kept by the engineer in charge of the plant, it was found that the average load per year was 175 ampères at 118 volts. The initial cost of the plant was $5,000, and allowing 15 per cent. interest, depreciation and repairs, this amounts to $750 per year. This, reckoned with the cost of additional labour, coal, oil, water and an item for waste, made a total cost of $2,851.20 for running the plant for 919,275 ampère hours, *i.e.*, for one year's lighting. The company's bills for the year previous to the installation of the plant amounted to $4,890.22, the price per lamp hour working out to three-quarters of one cent. This makes the total number of lamp hours per year 652,029, or 326,014 ampère hours. But the plant supplies light for an average of 919,275 ampère hours per year, and at the above rate the company would have charged $13,789.12. Hence the college saves $10,937.92 per year by having its own plant, thus decreasing the cost of lighting to about one-fifth what it otherwise would be; *i.e.*, the lighting costs on an average one-seventh of one per cent. per lamp hour. This instructive comparison was only arrived at after a careful examination of accounts, combined with tests of the boiler, engines, dynamos, &c.

Aberdeen Electric Lighting.—An electrical engineer is to be appointed by the Town Council at a salary of £200 per annum.

Central Stations in Switzerland.—*Sciences et Commerce* contains in its last issue an interesting table of central electric lighting stations established in Switzerland since March 1st, 1883. There are 59 in all, either in operation or projected.

Leicester Electric Lighting.—A very stormy meeting of ratepayers and property owners was held last week at Leicester, protesting what a "scandalous shame" it was that the Corporation should borrow £50,000 to introduce the electric light, in the face of the present financial condition of the town. A resolution in accordance with this view was passed. The meeting also pledged themselves to prevent, if possible, the sanction of the loan.

Wrexham Electric Lighting.—The Corporation has decided to take over the electric lighting provisional order and powers from the Wrexham and District Electric Light and Power Company, at a cost of £500. The Brush Company has been authorised to provide and erect a central station, according to plans and specification submitted, and to maintain the same for two years, and then to transfer the works and plant to the Corporation at the sum of £13,049.

Kensington Electric Lighting.—Sir Frederick Leighton, P.R.A., has called the attention of the Kensington Vestry to the fact that electric lighting mains had not been laid in Holland Park Road by the Notting Hill Electric Light Supply Company, and enquired whether the vestry can enforce the supply of electrical energy to his house, No. 2 in the road, or whether steps might be taken to rescind the company's order.

Static Charges on Metallic Telephone Lines.—Some curious effects have been observed on the metallic circuit telephone lines in Canada, and are described by Mr. F. J. F. Schwartz in the New York *Electrical Engineer*. "Since the building of several metallic lines which enter Montreal, disturbances of a static nature have attracted serious attention. These were first noticed during the winter of 1891, which was the first winter that the metallic lines were in use, and the duration of the disturbances has been from a few hours to several days, with varying intensity. The disturbances have occurred, thus far, only in cold weather, and generally about the time of a decided change. On several occasions snow was falling, and the lines were found to be heavily charged, the charging rapidly becoming less as the weather moderated. At the time when the disturbance was first noticed, trouble was caused by the sparking from some of the drop coils to the iron cores, whose supporting plates may have been grounded at the time. Shocks were occasionally received while inserting plugs into the jacks, but on listening on the lines they were usually found quiet. In order to keep the lines in use, and to prevent shocks, grounded retardation coils have been temporarily connected to the metallic circuits, and these have ordinarily served to rid the lines of the charge. No unusual disturbances have been noticed on the single lines."

Electrical Attractions at a Bazaar.—At a garden fête and bazaar being held in the grounds of Soho Square on the 8th, 9th and 10th inst., in aid of various pressing needs in the parish, we understand that among a host of attractions there are to be heard or seen, organ recitals by telephone between the church and the square, by the kindness of the National Telephone Company; electric lighting by Pritchetts & Gold; electrical cooking in full operation, apparatus lent by Crompton & Co., Limited; Edison's phonograph, by courtesy of Mr. W. E. Young and Mr. Lynd; and violin solos will be given by a gentleman not unknown in the electrical world. Go and sit in the square, under the canopy of heaven, eat an electrically cooked chop, the while listening to Madame Albani on the phonograph with the right ear, and to the soothing strains of St. Anne's organ with the left.

Thorn Electric Lighting.—This town is to be electrically lighted by Messrs. Siemens and Halske, and the station will be built at Leibitsch, three miles distant, on the Russian frontier.

The Electrolytic Separation of Antimony from Copper.—The separation of these two metals, which are frequently associated with each other in commercial samples, has long presented difficulties. These were first noticed by Wrightson (*Ztschr. An. Chem.*, xv., 297), although he observed the curious fact that when the copper is very impure it is possible to eliminate the antimony. Classen corroborates this statement, and finds that the separation may be made electrolytically in a solution of the double oxalates. But it is obvious that a better, more certain, and more practical separation is desirable, and this has recently been devised by Smith and Wallace. They electrolyse the copper-antimony in the presence of tartaric acid and ammonia with very satisfactory results. A very careful examination of the precipitated copper showed that it was not contaminated with the slightest trace of antimony.

The Electrolytic Separation of Mercury and Bismuth.—The question as to whether mercury can be completely precipitated by the electric current in the presence of nitric acid has been frequently discussed, and answered in the affirmative. In electrolytic literature it is this solution of mercury which has been generally recommended for the separation of this metal from other metals associated with it. Thus, in the latest edition (the third) of Classen's *Quantitative Analyse durch Elektrolyse*, p. 147, the author certainly leads one to infer that mercury can be separated from bismuth, in the electrolytic way, in the presence of nitric acid. But in Smith's *Electro-Chemical Analysis*, p. 97, the statement occurs that "mercury cannot be separated in the electrolytic way from silver and bismuth." The recent experience of Smith and Saltar with copper and bismuth confirm this observation. That others may be saved trouble, and be convinced that mercury and bismuth cannot thus be separated when present in nitric acid, E. F. Smith and J. B. Moyer have recently published an account of an investigation designed to support this view. In all their experiments, wherever precipitation occurred, the two metals were thrown down together. This was true under the most varying conditions; hence Classen's statement must be modified to accord with fact.

Testing Coal by Electricity.—It is not, perhaps, too great a flight of imagination to assign this title to a method which W. Hempel has recently devised for use in determining the character of coal. Sulphur is a troublesome constituent which the gas companies would rather have absent from than present in their coals; moreover it seriously impairs the quality of the gas produced. The "monopolists" recognise *now* that they must strain every point in order to produce good gas; this has been forced upon them by competition, hence in this respect, too, electricity has done the public good service. W. Hempel is one of the leading authorities on coal-gas in Germany, and he has recently adapted a method, first devised in more complex form by Berthelot, whereby the sulphur in coals may be estimated, and hence their suitability for gas-making determined before purchase. In doing this he has taken advantage of the cosmopolitan aid which electricity offers. The coal to be tested is powdered and pressed into a little platinum wire cylinder, to which a long platinum wire is attached, and then burned. The combustion is effected in an ordinary glass bottle, which is fitted with a trebly perforated India-rubber stopper. Through this passes a tube with a glass stopcock, and which widens out into a cylinder; also two glass tubes, to the lower ends of which are fused two long thick platinum wires. One of these wires carries the little platinum cylinder or basket already referred to. A little mercury is poured into the tube so as to establish sure contact with wires which lead the electricity. When the current is passed the platinum basket becomes white hot, the combustion of the coal is effected, and the gaseous products containing the sulphur compounds are led off through the stopcock and examined chemically. This method is exceedingly neat, and gives, it is said, very satisfactory results, which enable the character of the coal to be accurately determined.

Stafford Electric Lighting.—An electrical expert is to be engaged by the Town Council to report on the electric lighting scheme.

Electric Traction.—We understand that the two Houses of Parliament are nominating the following members to be the joint committee on electric powers protective clauses:—Earl Rosse, Earl Russell, Viscount Cross, Lord Clifford of Chudleigh, Lord Ker (Marquess of Lothian), Mr. Brunner, Mr. Forwood, Mr. Molloy, Sir Bernhard Samuelson, Major Darwin.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Birmingham Electric Supply Company, Limited.—The annual return of this company was filed on March 29th last, and shows that out of a nominal capital of £100,000 in £5 shares, that 20,000 shares have been taken up. A sum of £5 has been called on 10,000 of these, and £2 each on the remaining 10,000. The total amount of calls paid is £70,000.

Abell's Electrical Engineering Company, Limited.—The annual return of this company shows that out of a nominal capital of £5,000 in £5 shares, 360 shares have been taken up, with £3 called on each of 240 of these. The total amount of calls received is £720, and that agreed to be considered as paid is £600.

Anglo-Portuguese Telephone Company, Limited.—The annual return of this company was filed on April 11th, and shows that out of a nominal capital of £75,000, 50,000 shares of £1 each have been taken up, which have been agreed to be considered as paid.

Lancashire and Cheshire House-to-House Electricity Company, Limited.—The annual return of this company has been filed on May 8th, and shows that out of a nominal capital of £100,000, in 19,900 ordinary and 100 founders' shares of £5 each, 107 shares have been taken up. Nothing has been called on 7 shares; but £500 has been considered as paid on the remaining 100.

Maulove, Alliott and Company, Limited.—The annual return of this company, made up to the 6th ult., has just been filed, and shows that out of a nominal capital of £100,000 in £10 shares, 4,599 have been taken up, and 4,546 have been issued as fully paid. A sum of £530 has been called and paid on the remainder.

A. Ransome and Company, Limited.—The statutory return of this company, made up to the 10th ult., shows that the whole of the nominal capital of £59,000 in £10 shares has been taken up, and 5,593 of these were issued as fully paid. The other amounts have been duly called and paid.

Electrical Wonder Company, Limited.—The statutory return of this company has been made up to the 25th of March last, and shows that out of a nominal capital of £10,000 in 9,900 ordinary and 100 founders' shares of £1 each; 5,000 ordinary and 100 founders' shares have been taken up. The payments resulting from a call amount to £3,736 10s. There is £1,363 10s. not yet paid.

Andrews and Preece, Limited.—The annual return of this company, made up to March 21st last, reveals the fact that, out of a capital of £25,000 in 300 deferred and 2,200 ordinary shares, all of £10 each, the whole of the deferred and 418 ordinary shares have been taken up. There has been £10 called on each of 192 ordinary shares, and the total amount of calls received is £1,865. The sum of £5,260 has been agreed to be considered as paid, in respect of 300 deferred and 2,260 ordinary shares. There is £55 in arrear.

Association for the Protection of Telephone Subscribers, Limited.—The registered office of this company is now situated at 58, Coleman Street, E.C.

African Direct Telegraph Company, Limited.—The annual return of this company has been made, and shows that out of a nominal capital of £250,000 in £10 shares, 23,600 have been taken up, with £10 called on each share. The full amount has been paid.

Spanish National Submarine Telegraph Company, Limited.—The annual return of this company made on the 13th of last April, shows that 23,719 shares of £10 each have been taken up out of a nominal capital of £500,000, divided into 49,900 ordinary shares of £10 each, and 1,000 founders' shares of £1 each. The majority of these shares (23,715) have been issued as fully paid, and the full amount has been called on the remaining four shares, and all calls paid. The total amount of share warrants, comprising 55 shares of £10 stock, surrendered since the last summary, is £550.

Roger Dawson, Limited.—The statutory return of this company has lately been filed, and shows that out of a nominal capital of £15,000 in £1 shares, 14,993 were issued as fully paid. £1 per share has been paid on the remaining seven shares.

Arc Accumulator Company, Limited.—The annual return of this company was filed during the latter part of April, and shows that out of a capital of £1,000, in £1 shares, seven only have been taken up. There has been nothing paid on these.

Albert Hoster Company, Limited.—The annual return of this company was made a month or two ago, and shows that out of a nominal capital of £2,000, in £20 shares, only seven shares have been taken up, with the full amount called on each, which has been duly paid.

Atlas Carbon Manufacturing Company, Limited.—The registered office of this company is now at 19, Ewer Street, S.E.

American Insulated Wire Company, Limited.—The registered office of this concern, according to a notice lately filed at Somerset House, is at 15, Union Court, Castle Street, Liverpool.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bury (Lancs.).—July 15th. The Corporation of Bury invite tenders, to be accompanied with specifications and reports, for the necessary plant, distributing mains, machinery and incidental works required for the supply of electricity within the borough. Particulars may be obtained from Mr. J. Cartwright, Borough Engineer.

Portsmouth.—June 23rd. For supply and erection of certain electric cables, both high and low tension, conduits, feeding boxes, &c., for the Urban Sanitary Authority. Copies of specification and plan and form of tender can be obtained on application to Mr. A. Hellard, Town Clerk, Town Hall, Portsmouth on or after 5th inst. Further particulars can be obtained on application to Messrs. Kincaid, Waller & Manville, 29, Great George Street, Westminster.

Worcester.—June 24th. For erection of electric lighting station and buildings at Powick Mills, near Worcester, for the Council. Drawings and specification can be seen, and bill of quantities obtained, at the offices of Mr. S. G. Purchas, M.I.C.E., Guildhall, Worcester, on and after 19th inst.

CLOSED.

Ealing.—The Local Board have placed the contract for the construction of boilers and machinery at the Southern Sewage Works in connection with the electric lighting project, with Messrs. Watts & Co., of Soho, at the sum of £1,875. The following is a list of the tenders sent in:—

H. & T. Danks	£1,350
Hawksley, Wyld & Co.	2,650
J. Cochrane	2,200
Tinckers, Limited	2,200
Galloways, Limited	2,660
Fletcher & Co.	2,161
J. Watt & Co. (accepted)	1,875
Easton & Anderson, Limited	2,364
Penman & Co.	2,050
S. Hodge & Sons	2,175
J. Thompson	2,450

Kingston.—The Town Council have accepted the tender of Messrs. J. Allen & Sons to erect the electric lighting station for £3,656.

Liverpool Overhead Railway.—We understand that the contract for the extension from the new Rimrose Wall to Crosby Road, opposite the Caradoc Hotel, has been let to Messrs. Holme and King, a firm of local contractors.

Wrexham.—Brush Company for electric lighting the town under conditions stated in our "Notes" columns.

BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

Typewriters in Telegraphy.—At the National Fast Telegraphic Tournament, recently held in New York City, the first and second prizes in the message class were won by operators using the Caligraph typewriter. The contest was of an hour's duration, and 97 messages were received. There were thirteen competitors: five used the Caligraph, five the Remington, two the Smith-Premier, and one the Hammond. The contest brought out the working capacities of the various machines in a remarkable way. From the start, it was observed that the operators who used the Caligraph had a decided advantage. The level keyboard and slight depression of the Caligraph made the action of its operators seem graceful and easy compared with the laboured action of the operators of other machines, and were great aids to speed and accuracy. A key for every character allowed the Caligraph operators to properly punctuate their work, without danger of "double headers." The winner of the first prize was B. S. Durkee, of Portland, Oregon; percentage 96·46. The winner of the second prize was J. H. Jones, of San Francisco, Cal.; percentage 96·16. Both these gentlemen operated the Caligraph. The receiving accomplished by them was pronounced by the judges to be the fastest and best on record, the average time for each message, including number, address and signature having been only 40 seconds. The splendid record of the Caligraph on this occasion sufficiently demonstrates why it has become so universally popular in all branches of the telegraph service. Since the Postal Telegraph and Commercial Cable companies adopted this machine, its employment in other branches of telegraphy has been specially noticeable. Its latest and greatest achievement as a message receiver certainly shows that the companies have made a wise selection, and that as a means of insuring rapidity and correctness in the recording of messages the Caligraph surpasses all other typewriters.

Catalogues.—The Phosphor Bronze Company, Limited, have just published a splendidly prepared compilation, in which they describe manufactures of their metallic alloys, Bull's metal, phosphor bronze, and a variety of other metals. A number of testimonials as to the reliability of Weiller's patent silicium bronze wire, and some correspondence on phosphor bronze, which recently appeared in the *Engineer*, take up a good deal of space. There are some useful detailed tables of weights of round, square, and hexagon rolled metals and alloys, and coefficients of strength, at the end of the book. Several thoroughly good plates are included, among these being one of a second class Admiralty pattern torpedo boat, built entirely of rolled and drawn Phosphor Bronze plates and angles, also one of the composite racing yacht, *Eva*, built with angles and other parts in Bull's metal, and another full page illustration of a propeller blade cast in Bull's metal. The catalogue is made up of first-class paper, and is a capital specimen of nineteenth century printing and illustrating. On the covers is a novelty in the form of several handy scales according to various systems of measurements. Illustrations of the offices and foundry of the company are also given. An 1893 calendar is the central feature of the back cover. The catalogue altogether is a specimen of good workmanship both in preparation and in printing, and is very complete as a collection of the special points of interest in the company's business and manufactures.

A Defective Meter.—At the Brighton Police Court, last week, Joseph Hall was summoned as the secretary for the Mikado Creamery Company, King's Road, Brighton, for non-payment of £20 10s. 9d. for electricity supplied by the corporation and the rent of meter. The collector proved delivery of demands of £14 15s. 6d. for the quarter ending December 31st, and £5 15s. 3d. for the quarter ending March 31st. Defendant disputed the amount in the December quarter as excessive. The Deputy Town Clerk pointed out that by the Act the amount registered was conclusive evidence of the rate due, subject to application being made for the testing of the meter. Defendant said he was no party to the passing of the Act. The stipendiary said he had heard that objection before, but it would not hold. He gave judgment for the plaintiffs for the amount claimed. Subsequently the defendant returned and said the meter was changed in December, and the stipendiary allowed the case to be re-opened. Defendant said in December his meter stopped and was replaced by one of the Ferranti type. The stipendiary suggested that the charge for October and November might be agreed upon between the parties. He thought this was more a matter for the County Court. The case was eventually adjourned.

Hotel Electric Lighting.—The "King's Head" Hotel, Darlington, has been lighted throughout by electricity. The gas engine used for printing the *Northern Echo* at night, is utilised during the daytime to drive the dynamo for charging accumulators for lighting the hotel. Messrs. Cox-Walkers have carried out the work.

The Standard Gauge for Discs, &c.—Much confusion arises in the establishments of charcoal disc manufacturers when customers send orders for a number of discs of Standard or Birmingham wire gauges, just sufficient for one machine. This confusion is but natural, seeing that there are no such gauges used in the rolling of sheets. Messrs. Harold & Jenkins have forwarded us a list giving the thicknesses in decimals of an inch of Nos. 16 to 30 sheet iron gauge. These are the thicknesses recognised by sheet iron makers, and users of discs, &c., if ordering by these gauges can thoroughly depend upon securing thicknesses almost exact to those specified. It is not out of place to observe that for armature purposes the gauge now almost universally adopted is No. 24 sheet iron gauge (·025-inch, or 40 plates to the inch), and for transformer work No. 30 gauge (·0125-inch, or 80 plates to the inch).

New Branches.—A branch station has been established in Winchester House, Old Broad Street, E.C., by the Direct United States Cable Company for the transmission of messages to and from North and South America.

The "Electra Works," Vierordt & Co., of Rotterdam, have opened a branch office in London at 28, Falcon Square, E.C., where Mr. B. Hillmann will act as their sole agent for the United Kingdom. We have received a price list of the firms' manufacture of electric light carbons.

Messrs. A. Ardley & Son have taken over the premises No. 48, Cannon Street, and are opening the same for the supply of office furniture and fittings, iron safes, &c. The firm have a special department for electric lighting work.

Oxford Electric Company, Limited.—The directors are offering for sale at par a number of 5 per cent. debentures of £50 each, payable to bearer, being part of a total of £25,000, offered for sale at par. Interest payable half-yearly on January 15th and July 15th. These debentures are a first charge on the whole undertaking, present and future. They are secured by a trust deed entered into between the company and Sir Daniel Cooper, Bart., and Sir Henry C. Mance, dated October 11th, 1892. The accounts, as audited on behalf of the corporation, show that there has been an expenditure properly incurred on the undertaking of £55,154 6s. to December 31st last, since which date a further outlay of about £3,000 has been made.

Agricultural Exhibitions.—At the various provincial agricultural exhibitions, Messrs. W. H. Willcox & Co., of Southwark Street, London, are showing in great detail engine packings of all descriptions, lubricating and engine oils, steam engine and boiler mountings, Pickering's governors, a large number of brass, steam and other fittings, India-rubber and asbestos goods, tools in great variety, including drilling machines, screwing machines, and every requisite necessary for owners of agricultural and manufacturing machinery and employers of steam power.

Bergtheil & Young.—This firm are at present very busy in their contract department, having in hand the wiring of six houses in Balfour Place, including No. 2, the new town residence of Lord Folkestone, the lights in the aggregate amounting to 700, the interior lighting of the Weigh House Chapel, Thomas Street, Oxford Street; the fittings for Messrs. R. D. Warburg's offices at 41 and 42, Little Britain, 42, Harley Street, 482, Oxford Street, and an extension to the Stock Exchange Toilet Club, Old Broad Street.

Electric Light at Sheffield and Kingston-on-Thames.—Messrs. E. Green & Son, Limited, of Manchester and Wakefield, have secured the contracts for their improved patent fuel economisers to be supplied to the above installations. The advantages claimed by the makers of this apparatus for its economising properties are said to be fully borne out by the large number of orders recently received from Corporations who are adopting electric lighting.

Table d'Hote Dinners in Railway Trains.—The Midland Railway Company's announcement of the above, to commence both in first and third-class carriages next month, is more of a new departure than it even appears to be, as the work will be done entirely by the use of compressed oil gas in cooking apparatus specially designed by Messrs. Fletcher, Russell & Co., Limited, at their Warrington house.

Elmore's French Patent Copper Depositing Company, Limited.—Mr. Justice Vaughan Williams on Wednesday pronounced a compulsory winding-up order, but subsequently, it appearing that the petition had been made in the belief that it was unopposed, his Lordship withdrew the order, and directed the petition to stand over, with a view to arrangements said to be for the benefit of the creditors.

Bourne & Grant Electricity Supply Company, Ltd.—As some misapprehension appears to be extant consequent on the registration of this company, we are asked to state that the business of electrical engineers and contractors hitherto carried on by Messrs. Bourne & Grant is in no wise interfered with or altered by the creation of the company, which is a distinct and separate concern.

Personal.—Mr. Reginald J. Wallis-Jones, A.M.I.C.E., and M.I.E.E., has joined the staff of Messrs. Kincaid, Waller and Manville, consulting engineers, of 29, Great George Street, Westminster.

Removal Notice.—The General Electric Company, Ltd., notify that their Glasgow branch has been removed from 79, West Regent Street to 196, St. Vincent Street.

The Edison & Swan United Electric Light Company, Limited.—This company are now able to undertake at their works in London, silver plating, nickel plating, and gilding.

Private Electric Lighting.—Messrs. Paterson & Cooper have just completed a very extensive electric installation of 300 lights at Penbew Hall, Mold, Wales, the residence of Mr. H. W. Buddicom, J.P., D.L.

CITY NOTES.

Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited.

THE fourth annual report and statement of accounts, to December 31st, 1892, of the directors of Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, reads as follows:—

"The directors beg to enclose balance-sheet and profit and loss account for the year ending December 31st, 1892. From this it will be seen that the surplus for the year amounts to £224,083 11s. 6d., after payment of all expenses and deducting £30,000 as the original value of the American and Canadian patents sold in the course of last year. It will be noted that, as in the previous balance-sheet, all the shares and debentures are taken at par, it being impossible to judge of their real value at the present time. During the past year there have been various negotiations with regard to the sale of patents, but it has been impossible to conclude sales on terms that were at all advantageous to this company, as none of the subsidiary companies were, until lately, in a position to show continuous working on a reasonably large scale. The directors have pleasure in pointing out that their previous statements in regard to the successful practicability of the Elmore process are now borne out by the results of recent investigations and reports made by various experts and by committees of the shareholders of the English and French companies. For the information of those that are not shareholders in the French Elmore Company, it may be stated that recently Mr. Le Neve Foster, on behalf of some of the shareholders of that company, visited the works at Dives, and reported that the copper tubes manufactured there were of excellent quality, and certainly superior to the ordinary commercial solid drawn tubes, while he reported satisfactorily on the works. He calculated that, exclusive of depreciation, renewals, and repairs, and the expenses in Paris and London, a gross profit per ton of £16 15s. might be made when the works were turning out 60 tons per month, and a profit of £25 15s. per ton when the works were turning out 100 tons per month. These figures are arrived at from the actual working cost, and may be taken as likely to be increased rather than decreased. The policy adopted by this company of assisting the French Elmore Company until they had proved the process on a substantial scale has been successful, and has given a value to the securities held by this company in the various Elmore companies, and the patents in other foreign countries not yet disposed of. The French Elmore Company have sold their entire business to a new French company, formed in Paris, and are to receive £60,000 first mortgage debentures, £20,000 in cash, and founders' shares entitled to £4,500 per annum after the ordinary shares of the new company have received 10 per cent. in any year, and to half the remaining profits, and to certain rights in the event of a return of capital. Our own company have been asked to make certain reasonable concessions with regard to their interest in the French company, which will be explained at the general meeting. The directors have been informed that the company formed in France under the title of E. Secrétan & Co., to take over the business of the French Elmore Company, has closed its subscription list, having received a full subscription of £80,000; and that the preference shares issued by the English Elmore Company have also been fully subscribed. These facts alone indicate the soundness of the Elmore businesses, and the confidence with which they are regarded by those who take the trouble to satisfy themselves as to what has really been already accomplished by the manufacturing companies. The raising of the capital necessary for the development of the Elmore business in France ought rapidly to result in the American Elmore Company being able to dispose of its patents, in which this company is interested. As the position taken up by this company was in some respects antagonistic to the Austrian Elmore Company, Mr. Macfarlan, who is a director of that company and of this company, considered that he could not remain as a director of both companies, and consequently has retired from the board of this company. Mr. J. J. Atkinson retires, but, being eligible, offers himself for re-election. Messrs. Jackson, Pixley & Co. offer themselves for re-election as auditors of the company.

BALANCE-SHEET, December 31st, 1892.

Dr.	£	s.	d.
To Capital authorised and issued, viz.: 15,000 priority shares of £5 each, fully paid, £75,000; 9,000 founders' shares of £5 each, fully paid, £45,000	120,000	0	0
„ Sundry creditors, viz.:—On open account, £6,248 7s. 11d.; on bills payable, £419 7s. 4d.	6,667	15	3
„ Liability on securities of this company in connection with loans to Elmore's French Company, £69,274 18s.; on contingent liability in respect of bills receivable discounted, £2,500.			
„ Profit and Loss— Balance as per account	224,083	11	6
	£350,751	6	9

Cr.	£	s.	d.
By Purchase of patents, £80,000; less estimated value of American and Canadian patents sold during the year, £30,000...	50,000	0	0
„ Sundry investments at par and cost prices, viz.:—Elmore's French Company preference shares at £2 per share, £13,100; ditto, ordinary shares at £2 per share, £50,850; ditto, at cost price, £292 5s. = £51,142 5s.; Elmore's German Company shares at £2 per share, £58,758; Elmore's American Company deferred shares at £2 per share, £56,000; Elmore's German Company debentures at par, £6,163; ditto, at 80, £4,541 3s. = £10,704 3s.	189,704	8	0
„ Investments held by sundry persons as security for loans to Elmore's French Company, as per contra, viz.:—Elmore's French Company debentures at par, £18,000; ditto, at 80, £258 8s. = £18,258 8s.; ditto, ordinary shares at £2 per share, £1,250; Elmore's German Company debentures at par, £24,000; Elmore's American Company priority shares at £2 per share, £25,954, less calls unpaid, £187 10s. = £25,766 10s. ...	69,274	18	0
„ Sundry debtors	163	3	2
„ Loans to Elmore's French Company	39,353	9	3
„ Debenture interest due from Elmore's German Company	2,081	10	6
„ Cash in hand, and at bankers	45	14	6
„ Office furniture	128	3	4
	£350,751	6	9

PROFIT AND LOSS ACCOUNT for the year ending December 31st, 1892.

Dr.	£	s.	d.
To Directors' and auditors' fees and salaries	1,872	10	8
„ Maintenance of patents, and legal and professional charges	733	12	1
„ Rent, rates and taxes	266	0	0
„ Stationery, printing and advertising	24	14	2
„ General office expenses	28	0	7
„ Depreciation in the value of shares sold	8,775	0	0
	11,699	17	6
„ Balance carried to balance-sheet	224,083	11	6
	£235,783	9	0

Cr.	£	s.	d.
By Balance from last year	132,203	1	1
„ Sale of American and Canadian patents in shares and cash, £127,334; less estimate of original cost of ditto, £30,000	97,334	0	0
„ Interest including bonus due from Elmore's French Company for advances and loan of securities	6,205	16	11
„ Transfer fees	40	11	0
	£235,783	9	0

We have examined the above accounts with the books and vouchers of the company and certify the same to be in accordance therewith. We have also inspected the securities, with the exception of those held as security for loans to Elmore's French Patent Copper Depositing Company, Limited, now in liquidation.

JACKSON, PIXLEY, BROWNING, HUSEY & Co.,
Chartered Accountants, *Auditors.*

58, Coleman Street, E.C., *May 30th*, 1893.

Electric and General Investment Company, Limited.—The directors have resolved, subject to the completion of the audit, to recommend the payment on July 1st next, of the following dividends:—On the ordinary shares at the rate of 30 per cent. per annum on the capital paid up for the six months ended May 31st last, making, with the interim dividend already paid, 25 per cent. for the year, and on the founders' shares £30 per share.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 4th, 1893, amounted to £914; week ending June 5th, 1892, £782; increase £132; total receipts for half-year, 1893, £19,493; corresponding period, 1892, £17,869; increase £1,624.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of May were £3,700; as compared with £3,072 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of May, 1893, amounted to £1,866, against £2,132 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in May, 1893, were £24,000; January 1st to May 31st, 1893, £108,000; corresponding months, 1892, £104,800; corresponding months, 1891, £114,000.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 2nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,438.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, June 1st.	Closing Quotation June 8th.	Business done during week ended June th, 1893. Highest.	Lowest.
195,100£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 —104	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	50½— 51½	50 — 51	50	...
2,932,680£	Do. do. 6 p. c. Preferred	Stock	92 — 93	92 — 93	92⅞	91⅞
2,876,140£	Do. do. Deferred	Stock	11⅛— 11⅜	11 — 11⅛	11⅛	11⅛
130,000	Brazilian Submarine Telegraph, Limited	10	11⅛— 12	11⅜— 12⅛	12	11⅞
36,400£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛— 3⅜	3⅛— 3⅜	3 3/16	3⅛
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2⅛— 2⅜	2 5/16	2⅛
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	108 —110	108 —110	108	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	1½— 2½	1½— 2½	...	...
630,000£	City and South London Railway	Stock	37 — 39	37 — 39	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11⅜— 12¼	11½— 12	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12½— 13	12⅝— 13	13	12⅝
$ 1,716,000	Commercial Cable, Capital Stock	$100	140 — 150	140 —150	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	3/16— 5/16	3/16— 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 5⅝	5½— 5⅝	5 5/16	5 5/16
16,000	Cuba Telegraph, Limited	10	11½— 12½	11½— 12½	12¼	11 13/16
6,000	Do. do. 10 p. c. Preference	10	18½— 19½	18½— 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅛— 11⅜	11⅛— 11⅞	11⅞	11⅜
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15⅛— 15⅜	15⅛— 15⅜	15⅜	15⅛
70,000	Do. 6 p. c. Preference	10	16½— 17	16½— 17	17	16⅜
1 5,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,594,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	112 —115	114	112½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅝— 15⅞	15⅝— 15⅞	15⅞	15⅜
70,600£	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	104 —107	...	...
250,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	104 —107	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	111 —114	112 —115	114	113
108,700£	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	104½	...
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	102½	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	2 — 2½	2 — 2½	2⅜	2¼
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1/16— 1/8	1/16— 1/8	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3/16— 1/4	3/16— 1/4	1/4	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1/8— 3/16	1/8— 3/16	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	1⅜	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜— 9⅞	9⅜— 9⅞	9⅞	9⅜
160,042	Do. do. 6 p. c. Preference	10	15½— 15¾	15½— 15¾	15 15/16	15½
150,000	Great Northern Tel. Company of Copenhagen	10	19½— 20	19½— 20	19 15/16	19½
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	107	106
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6½— 7½	6½— 7½	...	..
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22½— 23½	22½ - 23½	23½	22½
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 43	40 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4⅛— 4½	4⅛— 4½	4⅜	4 1/16
10,000	Do. do. fully paid	5	6⅛— 6⅜	6⅛— 6⅜	6⅜	5⅞
37,548	London Platino-Brasilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	..
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6 — 6½	6 — 6½	6 5/16	...
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	101 —104 xd	101 —104 xd	104	...
458,867	National Telephone, Limited, Nos. 1. to 438,984	5	5 — 5⅛	5⅛— 5⅜	5⅜	5 1/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14⅜— 15½	14⅜— 15½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14½— 14⅝	14½— 14⅝	...	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅜— 5⅝	5⅜— 5⅝	5⅝	5 5/16
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —115	112 —115	114	...
48,800£	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16— 1/8	1/16— 1/8	...	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	101 —104	101 —104	...	...
11,802	Reuter's Limited	8	7 — 8	6 — 7	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7⅛— 8	7⅛— 7⅜	7⅜	7⅛
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8⅛	8 — 8⅛	8⅜	...
3,381	Submarine Cables Trust	Cert.	119 —124	119 —124	119½	119¼
78,949	Swan United Electric Light, Limited ... ... (£3¼ only paid)	5	3 — 3⅛	2¼— 3	2⅜	2⅜
37,350	Telegraph Construction and Maintenance, Limited	12	30 — 32	31 — 33	32½	31
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	104½	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5⅛— 6⅛	5⅛— 6⅛	...	...
260,900£	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	...	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	3⅜	3⅜
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	103 —107	103 —107	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7⅛— 7⅜	7⅛— 8	7⅜	7⅛
33,129	Do. do. do. 5 p. c. Cum. Preferred	7⅛	5⅝— 6⅛	6 — 6⅛	6⅜	6 1/16
33,129	Do. do. do. 5 p. c. Deferred	7⅛	1⅜— 2⅛	1⅜— 2⅛	...	...
178,100£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
222,700£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	..
88,321	West India and Panama Telegraph, Limited	10	1⅛— 1⅜xd	1⅛— 1⅜xd	1 5/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11⅛— 11⅜xd	11 — 11⅛xd	11⅜	11
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9½—10½ xd	9½— 10¼xd	9½	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	108 —111	108 —111	...	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	102⅜	...
49,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅛— 5⅜	5⅛— 5⅜	...	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅛— 5⅜.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1½—2½.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5— 5⅛.—House to House Company (£5 paid) 1⅛—2⅛.—Do. 7 per cent. Preference of £5, 5—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—5⅝, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6⅛.—Liverpool Electric Supply Shares of £5 (fully paid), 6⅛—6⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, 6 per cent. £100 Debentures, 101—103. Bank rate of discount, 3 per cent. (June 8th, 1893).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

THE DISTRIBUTION OF POWER BY ALTERNATE-CURRENT MOTORS By ALBION T. SNELL, Member. (Read April 13th, 1893).

(*Concluded from page* 668.)

6.—PRACTICAL APPLICATION OF THE DREHSTROM.

With a view of adding to the somewhat scanty practical information on the subject of multiphase working, the author proposes to lay before the Institution a few tests of two Drehstrom machines, designed and built by himself some 18 months ago. These machines were adapted from material at hand, and were built under restrictions as to cost and time, and thus can only be regarded as rough experimental designs. The dynamo was a Gramme-wound 10-unit two-pole shunt machine, designed to give 160 volts and 60 ampères, at a speed of about 1,000 revolutions per minute. Three insulated copper rings, with suitable brushes, were fitted around the commutator, and connected to the windings of the armature at points 120° apart. The ordinary commutator and brushes were left intact, so that both direct and triphase currents could be taken from the armature, and the field was separately excited. At a speed of 720 revolutions per minute, the frequency was 12 ~ per second. This was afterwards increased to 33 ~ by raising the speed of the armature.

The motor was specially built, and had a laminated ring magnet, with Gramme windings, and a closed circuit armature. It was estimated to give 3 B.H.P. at about 1,200 revolutions per minute, and the gross weight was approximately 300 lbs. The armature plates had holes drilled parallel to the shaft, and as near to the periphery as possible, without breaking through. In these were placed lengths of No. 4 S.W.G. copper wire, insulated from the plates, and soldered at either end to massive copper rings. The field winding consisted of six coils, each containing 68 turns of No. 6 S.W.G. copper wire, and having a resistance of 0·055 of an ohm. Opposite coils were joined in series with each other, so as to make three separate circuits, each of 136 turns and 0·11 of an ohm resistance, which could be connected in star or triangle fashion, as desired. This motor proved to be a very effective machine, having considerable torque at starting, and a speed regulation quite as good as a direct-current machine of similar output. The only instruments available for taking electrical measurements were a Cardew voltmeter and a Siemens dynamometer; hence it was not possible to measure the angle of lag, or estimate the true watts. The experiments made with the dynamo and motor are shown in the following curves and tables, which at this stage may be instructive, since they show the order and direction of the difficulties met with in Drehstrom working.

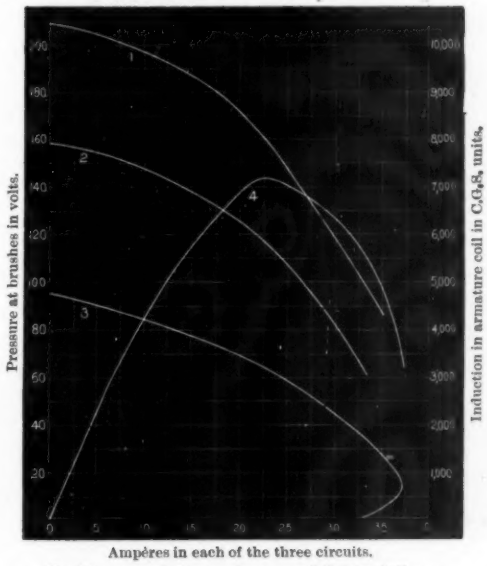
(*a.*) *Preliminary Experiments with the Dynamo.*

The three copper rings were connected to points in the winding at 120° apart, the Gramme winding being otherwise untouched. The arrangement is diagrammatically represented by fig. 14. The field

Connections of Drehstrom dynamo, coils in series.

FIG. 14.

was separately excited by 3·05 ampères, and the speed was kept at 710 revolutions per minute. The load was absorbed by iron spiral resistances with small self-induction. Readings were taken of the direct pressure; the alternating pressure at the ends of the three coils, a_1, a_2, a_3; and the current in each of the three mains, A_1, A_2, A_3 (see fig. 15, curves 2 and 3). It was found that with the armature unloaded the pressure developed by each coil was practically the same; this was also the case when they were equally loaded (see fig. 16). But it fell rapidly as the current increased, and so a considerable difference could be made between the pressure of the three circuits by simply giving different loads to each of them. The magnetic induction of the armature core, curve 1, fig. 15, was calculated from the usual formula, $E_a = \frac{N A n}{10^8}$, where E_a equals the total number of volts in the armature, A the number of turns counted all round the armature, N the total flux, and n the number of revolutions per second. It will be seen that the values of the induction measured were all small. The frequency was 12 per second. These conditions were not the most favourable, it is true, but they showed the detrimental effects of internal resistance and self-induction in not only restricting the output, but also in affecting the regulation of the pressure of distribution. It will also be seen that the direct pressure is higher than that of the alternating in the proportion of 158 to 94 on open circuit; and with 20 ampères in each branch (or a total of 1·732 × 20 = 34·64 from the combined circuit) in the proportion of 124 to 70. This difference is to be expected, since the alternating pressure is the average value of 120° of the differential curve of potential; and, further, when the armature is loaded, the self-induction probably increases the difference between the two values. The

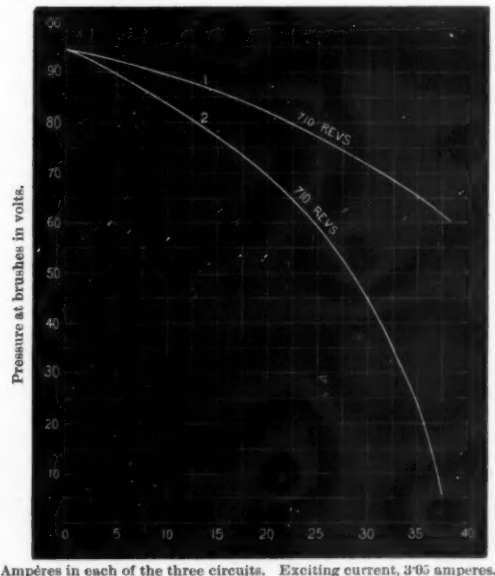


Ampères in each of the three circuits.

Exciting current, 3·05 ampères; speed, 710 revolutions.
Curve 1. Induction in armature core. Curve 2. Direct pressure. Curve 3. Alternating pressure. Curve 4. Apparent watts in each circuit; to read watts multiply ordinates by 10.

FIG. 15.

apparent output, curve 4, fig. 15, estimated by the product of effective ampères and volts, is found to be a maximum with about 22·5 ampères in each circuit, or 39 in all. The apparent load was next increased in each circuit so as to find the slope of the external characteristic curve. It was found to steadily fall at about the same slope until 37·5 ampères were reached, corresponding to a torque due to 65 ampères, this current being rather more than that designed for the armature. At this point the belt began to slip, and the experiment was stopped. It is clear that this class of dynamo can be safely overloaded for short periods.



Ampères in each of the three circuits. Exciting current, 3·05 amperes.
Shows fall of pressure at terminals of Drehstrom dynamo, with armature coils coupled as in fig. 14.
Curve 1. Only one circuit loaded. Curve 2. All three circuits equally loaded.

FIG. 16.

The winding of the armature was next divided into six equal parts and opposite sections were joined in parallel (see fig. 17).

The copper rings were then connected as before to points at 120° from each other. Each of the three circuits had now only half as many turns as with the coupling shown in fig. 14, and one-fourth the resistance. The effect of this alteration was to lower the internal resistance of the armature, and also, presumably, to reduce the self-induction. The excitation was maintained as before at 3·05 ampères,

and the speed also at 710 revolutions. The results obtained from the two couplings are shown in figs. 16 and 18 respectively. It is noticeable that the parallel winding has not materially affected the apparent output of the dynamo. The effective number of turns in each coil is only one-half that with the series winding; and, therefore, for the same heating effect the number of ampères is twice as great. To compare the two outputs, then, it is necessary, with the series arrangement, to take only half as many ampères as with the

Connections of Drehstrom dynamo, opposite coils in parallel.

FIG. 17.

parallel one. Referring to figs. 16 and 18, it is found that the apparent watts at 710 revolutions per minute are severally 69 × 20 and 34 × 40, or approximately the same. There was probably a smaller lag of current with the parallel than with the series connections. The smaller pressure and larger current were most suitable for testing the motor, and so the parallel connections of the dynamo armature were used during the whole of the following experiments.

(b) Experiments with the Drehstrom Motor.

1. *Star* or *open-coil* coupling. The motor was coupled to a dynamo by belting and then supplied with current at frequencies ranging between 12 and 33·3 ~ per second. With the lowest frequency the motor ran light at about 700 revolutions per minute, being nearly synchronous with the dynamo. As the load was applied the speed decreased, and since the output was inconveniently small, the dynamo speed was raised to about 900 revolutions per minute, when the following readings were taken:

GROUPS A AND B.

No. of Test.	Speed of motor.	Pressure on mains.	Ampères in each circuit.	Exciting current in dynamo field circuit.
1	848	58	21	2·5
2	746	55	21	2·8
3	880	77	38	4·5
4	800	77	27	Not taken.
1	888	80	28·7	4·3
2	866	80	27·6	4·3
3	824	75	27·6	4·3
4	890	77	28	3·9
5	790	70	27·6	3·9
6	866	75	27·6	3·9
7	Armature held stationary.	70	34·7	3·9

The frequency was about 15 in the above experiments; but the dynamo speed varied from 932 to 833 revolutions per minute, owing to the engine governing badly.

The load on the engine was next adjusted so as to give a steady dynamo speed of 960 revolutions, and the tests included in Groups C, D, and E were made.

In C a prony brake was applied to the pulley of the motor, and in D and E a dynamo was driven, as in the tests of Groups A and B, this being found to be more convenient.

GROUP C.

No. of test.	Motor speed.	Pressure on mains.	Ampères in each circuit.	Weight on end of 24" brake-arm.
1	736	84	31	2 lbs.
2	624	82	32	3 "
3	500	83	32·9	4 "
4	500	81	33	4 "
5	340	84	34·7	5 "

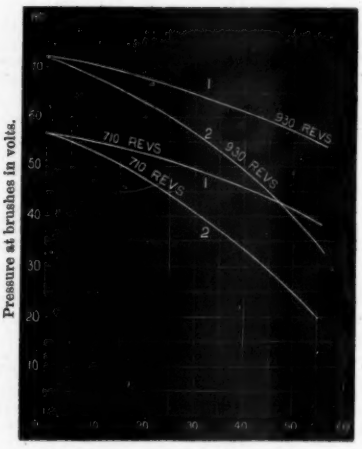
The frequency was 16.

GROUPS D AND E.

No. of test.	Motor speed.	Pressure on mains.	Ampères in each circuit.	Dynamo speed.
1	0	79	37·8	960
2	340	79	34·8	960
3	512	78	32·5	960
4	740	77·5	30·6	960
5	820	77·5	28·15	960
6	864	76	28·1	960
1	922	91	31	952
2	914	90	32·9	956
3	0	85	39·8	970

In both D and E the frequency was approximately 16.

Next, the dynamo speed was increased to 1,960 revolutions in Group F, and to 2,000 revolutions in Group G; and the motor connections were altered to the *triangle* or *closed type*. This required 1·732 times the current and 1/1·732 times the pressure for the same output with the *star* or *open type* connections (see latter part of 5). The prony brake was used in Group F.



Ampères in each of the three circuits. Exciting current, 3·05 ampères.
Shows fall of pressure at terminals of Drehstrom dynamo, with armature coils coupled as in fig. 17.
Curve 1. Only one circuit loaded. Curve 2. All three circuits equally loaded.

FIG. 18.

GROUP F.

No. of Test.	Motor speed.	Pressure on mains.	Ampères in each circuit.	Weight on 24" brake-arm.	B.H.P. of motor.
1	1,820	41·5	26·5	1	0·68
2	1,480	41	29·8	3	1·67
3	1,200	40·5	31	4	1·8

The frequency was 32·6.

GROUP G.

No. of test.	Motor speed.	Pressure on mains.	Ampères in each circuit.
1	0	36·5	39·4
2	732	37	35
3	1,000	37·75	35
4	1,276	38·75	30·5
5	1,702	41·5	27
6	1,750	42·5	27 Motor running free.

The frequency was 33·3.

Groups A and B were made to see how far the excitation of the dynamo affected the experiments. The pressure on the mains varies, of course, with the excitation; but the speed of the motor, as far as can be seen from these rough measurements, is nearly independent of the pressure, and seems rather to vary with the frequency, and perhaps the lag. The law connecting speed and current variation for constant frequency and pressure of supply is not very obvious, and evidently requires the lag to be taken into account. For example, see Group B: in test 6 the motor loaded with 27·6 ampères in each circuit and 75 volts, makes 866 revolutions; and test 7 shows zero speed for 70 volts and 34·7 ampères. Evidently the lag in 7 is far

greater than that in 6. This is confirmed by test 1 in Group D, by test 3 in Group E, and test 1 in Group G. It is curious to notice how small are the variations of current between running light and full load, or even when the armature is held stationary. This large waste or idle current is most prejudicial, and if it cannot be lessened by some practical means (by condensers or otherwise), will militate seriously against multiphase motors without commutators. If the revolving part of the motor be supplied with the triphase current, these troubles will be much less, because the moving part will contain less iron, and hence the hysteresis and eddy-current losses, and the induction disturbances will be of less importance. The frequency in the induced circuit is then so small as to give little trouble.

In Group C a prony brake, with a lever 2 feet long, was fitted around a 6-inch pulley, and the motor was supplied with current of 16 ~ per second. The pressure and current variations are seen to be insignificant, though the speed varies some 50 per cent. This low frequency (16) was found unsuitable for the design of the motor, since it gave too low a speed; but the tests in Groups D and E were taken so as to show the capabilities of the motor under these conditions. The power of the motor was utilised to drive a direct-current dynamo, the two machines being coupled by a belt. The figures in Group D again show large variations of speed for nearly constant pressure and small changes of current. In Group E the pressure was increased, but only a few readings were taken, as the increase of speed was insufficient to give results widely different from those obtained in the preceding tests.

In the next experiments the connections of the motor were altered to the *triangle* or *closed* arrangement, the end in view being the increase of motor speed and consequent output.

The tests in Group F are some of the most important in the series, for the output measured by the prony brake was sufficiently large to give practical data. It will be seen that the frequency was 32·6 per second, and the pressure about 41 volts. The speed again shows large variations. When running light the speed of synchronism, 1,960 revolutions, was nearly attained.

In Group G the motor was coupled to a small dynamo by a belt, and the frequency was raised to 33·3 per second. In test 6 the motor was running free, but the speed was 250 revolutions below that of synchronism. The best results seem to have been obtained with a frequency of about 32 (test 3, Group F), and it appears probable that if the arrangements had been such as to admit of a larger current at this frequency, at least 3 B.H.P. might have been taken from the motor.

These rough experiments show the importance of reducing the magnetising current to a minimum. It can be accomplished by careful attention to the design and by making the air gap as small as possible. The Drehstrom motor may be regarded as an open magnetic circuit transformer, and the only way to lessen the waste current is to make the magnetic resistance as low as possible. Mr. C. E. Brown has already suggested bedding the field as well as the armature turns in iron, the method being applicable to either ring or drum windings.

7.—Drehstrom Motors with Stationary Armatures.

Triphase motors are sometimes made with the rotary magnetic field in the revolving part of the machine. This necessitates brushes and rings, it is true, and consequently simplicity of design is departed from; but it must be recollected that there can be no sparking under ordinary conditions. The brushes would probably be made of flexible strands of copper, such as are commonly used for alternators. The chief point gained is, that the most marked effects of hysteresis, eddy-currents, and self-induction are limited to the relatively small moving part of the machine; whilst the massive stationary portions, which then form the armature, are magnetised by currents of frequency equal only to the difference between the speed of the armature and that of the rotary field. It is clear that the speed of the revolving part can never equal that of the rotary field; but at normal loads the period of the armature current will be small, and therefore the heating from hysteresis, &c., will be comparable with that of a direct-current machine, the period being probably of the order of from 8 to 10 per second. Herr Dobrowolski's 2-H.P. motor, described in the *Electrician*, August 7th, 1891, is of this type, and a brief comparison with the small motor built by the author may be interesting, because it will show the order of the results obtainable from the two types of machines. Herr Dobrowolski's motor weighed approximately 365 lbs., and the maximum output deemed advisable was 4 B.H.P. at about 1,700 revolutions per minute. On open circuit it made 2,100 revolutions, and at 2 B.H.P., the rated output, about 1,950. The frequency was 35, the supply pressure 70 volts, and the torque at starting considerable. The lag was stated to be 72 degrees when the motor was running light, 28 degrees at 2 H.P., and 22 degrees at 3 H.P. The efficiency at 1 H.P. was 75 per cent., at 2 H.P., the rated output, it had reached to about 80 per cent., and at 2·3 H.P. it attained its maximum of 81·4 per cent. The author's motor weighed about 300 lbs., and at 1,200 revolutions gave 1·8 H.P. on the brake; and it was evident from the slight heating that this output could have been safely doubled if the speed had been raised to about 1,800 revolutions. But it had a larger lag than the other machine, the waste currents at small loads were much greater, and the all-round efficiency was certainly less.

8.—Combined Rotary and Synchronous Motors.

A multiphase dynamo requires the revolving field magnets to be separately excited by a direct current. It is reversible, and will run as a motor if supplied with a multiphase current, but is not necessarily self-starting, and probably will not start against a large torque. If, however, the magnets be rotated so as to synchronise with the rotary magnetic field, the motor will work as satisfactorily as a single-phase machine.

Attempts have been made to combine the advantages of a self-exciting rotary field and a synchronous motor. The plan proposed is some modification of the following idea: The moving part, usually the armature, is wound with two circuits, the one closed on itself acting precisely as the closed circuits of the multiphase armature, the second supplied with a direct current, and, therefore, having fixed poles. When the field is excited by a rotary current the induced currents in the closed circuits will start the armature (if the torque be not too great), and the permanent poles due to the direct current will have but little influence. But as the speed of synchronism is approached the induced currents in the armature will decrease, and the fixed poles will have more effect, until finally the armature rotation will be entirely due to them.

Such a motor has many disadvantages, besides requiring an independent direct current. It necessarily has a low efficiency at starting and at all speeds below that of synchronism; but within wide limits of load, when once started, it will run at a constant speed with a high efficiency.

The initial torque cannot be so great as that of a simple diphase or Drehstrom winding, since the closed circuits on which the starting depends are relatively smaller.

Mr. Schuckert has built a self-exciting diphase rotary field synchronous motor on the above principles. But the method does not appear to offer any special advantages, and it is not likely that such motors will supersede ordinary single-phase alternators.

9.—Single-Phase Non-Synchronous Motors—Self-Exciting and Self-Starting.

Messrs. Hutin and Leblanc, C. E. L. Brown, and others, have devised modified forms of Prof. Elihu Thomson's motor, all of which will run with single-phase currents, non-synchronously and with good efficiency.

The principle seems to depend on the induction of currents in short-circuited coils, in unsymmetrical positions with reference to the main field, but this end is not necessarily attained by brushes and rings, as in Thomson's motor,* but by the rotation of the armature itself. In its simplest form this type of motor has no commutator, and is self-exciting, but will not start. If, however, the armature be spun in *either* direction, it will rapidly acquire the speed corresponding to the torque, and will then revolve at a uniform rate.

By the combination of an additional rotary magnetic field, the armature can be made to start against a considerable torque, and the auxiliary field can be stopped after the proper speed is attained. Various devices to secure such a field are suggested by Mr. C. E. L. Brown,† the most feasible being two parallel windings on the field magnets, one with small self-induction (or even capacity), and the other with larger self-induction. These two circuits when supplied with a single-phase current will produce a rotary field, and so cause the armature to revolve. Other forms of this ingenious motor have been suggested by Mr. Brown, for which reference should be made to the technical journals of March of this year. Most of the arrangements, however, necessitate rings and brushes, and the motor is therefore only preferable to a synchronous reversed dynamo inasmuch as it is self-exciting and self-starting. These two points are of great importance with small motors, and probably the invention will be of utility in many ways.

The general details of construction are similar, broadly, to those of a multiphase motor, but the number of poles in the field magnets and armature must not have a common factor, and the windings of both armature and field magnets are preferably laid in grooves or holes in the iron—an arrangement which permits the magnetic resistance to be reduced to a minimum and decreases losses from Foucault currents, while the weight output is increased. This is, perhaps, the best type of single-phase motor up to date, but it is undoubtedly susceptible of considerable improvement, and the problem of alternate current motors suitable for running on ordinary supply circuits cannot yet be said to be satisfactorily solved.

The author has to thank several members, especially Prof. W. E. Ayrton and Dr. Sumpner, for kindly discussing with him some of the points raised in the paper; but he alone is responsible for all inaccuracies and oversights.

THE EXCURSION OF THE DIAPHRAGMS OF TELEPHONES.

Observations have been made from time to time by different observers with the object of determining the extent of motion of a telephone diaphragm; but the results differ very widely. Dr. C. J. Blake obtained a value of 0·02 mm., by inscribing the vibration on a smoked glass; and by the use of a micrometer screw with electric contact he estimated it at 0·0135 mm.; Salet, Fröhlich, Franke, and others have given their results from ·0002 mm. to 0·035 mm., the minimum value being $1·2 \times 10^{-6}$ mm. There is no doubt that these differences are owing to the various current strengths employed, the dissimilarity in the transmitters used, and the general want of agreement between the various apparatus.

In 1890 a paper was published in the *Proceedings* of the Massachusetts Institute by Messrs. Charles R. Cross, and H. E. Hayes, in which it was shown that with a magneto telephone receiver the magnitude of the change in the strength of the magnet, when a weak current is sent through the coil, increases up to a certain limit, as the strength of the magnet is increased, and then diminishes. The

* See *Electrician*, March 16th, 1893.

† All of these have already been referred to in the first portion of this paper.

explanation of this diminution being found in the approach of the diaphragm towards saturation. The effect of the thickness of diaphragms was also studied, and it was found that, within the limits of the experiments, the changed strength of the magnet due to the weak current is greater with thin than with thick diaphragms. The subject was further developed by Mercadier, whose work is published in *Comptes Rendus*, Vols. cviii. and cxii.

Mr. Cross, in conjunction with Mr. Arthur N. Mansfield, has now concluded some further experiments in this direction. The telephone had a magnet of Norway iron three-fourths of an inch in diameter and 8 inches long. It was wound with two coils. The first was a magnetising coil of 2,750 turns, and of 8 ohms resistance; the other was the line coil of about 100 ohms. The distance between magnet and diaphragm was $\frac{3}{64}$ths inch. The strength of the magnet could be varied by suitably altering the current through the magnetising coil. An alternating current from a transformer was sent through the line coil. The extent of excursion of the diaphragm using various strengths of magnet and line current was measured by a stroboscopic arrangement.

One result of these experiments is to show that on increasing the magnetising current the corresponding permanent deflection increases more and more rapidly in proportion up to about $\frac{3}{10}$ths of an ampère, after which the deflection is very nearly proportional to the current. Similarly it appears from their results that as the strength of the magnet of the telephone increases, the amplitude of the vibration likewise increases up to a certain limit and then falls off. A comparison of these amplitudes with a curve representing the magnetisation of the magnet as determined by a ballistic galvanometer showed that the maximum motion of the diaphragm with a given value of the alternating line current is reached before the core reaches half saturation. The same curves also exhibit the fact that in general the amplitude of vibration of the diaphragm increases less rapidly than the current actuating the telephone. The results are contributed to the Massachusetts Institute of Technology, and appear in their reports for May.

NEW PATENTS—1893.

10,205. "Electric steering gear." F. L. DYER and L. H. DYER. Dated May 23rd. (*Complete.*)

10,207. "Improvements in electrodes for arc lamps." A. C. SEIBOLD. Dated May 23rd. (*Complete.*)

10,218. "Improvements in methods of regulating the distribution of electricity, and in converting its energy into that of light." R. WOOD. Dated May 23rd.

10,242. "Improvements in telephonic apparatus." C. ADAMS-RANDALL. Dated May 24th.

10,283. "Improvements in and connected with the manufacture of electrode plates for secondary batteries." J. E. HOFMANN. Dated May 24th. (*Complete.*)

10,298. "Improvements in dynamo-electric machines." W. B. SAYERS. Dated May 24th.

10,304. "Improvements in lighting and extinguishing electric lamps for street lighting." J. LOBLEY. Dated May 24th.

10,311. "An improved electric escapement to counters, clockwork, and the like." W. A. M. BROWN. Dated May 25th.

10,336. "Improvements in microphonic contacts." G. L. ANDERS and W. KOTTGEN. Dated May 25th.

10,347. "Improvements in or connected with battery switches." H. K. SPANGENBERG. Dated May 25th. (*Complete.*)

10,363. "Improvements in electrically controlled arc lamps." F. T. SCHMIDT. Dated May 26th.

10,382. "An improved switch for electric appliances." T. E. CARMICHAEL. Dated May 26th.

10,396. "Improvements relating to electric conductors." W. L. DUDGEON. (Communicated by La Société Anonyme John Cockerill, Belgium.) Dated May 26th.

10,398. "Improvements in effecting electrical communication with vessels or buoys at sea." G. C. L. LENOX. Dated May 26th.

10,399. "An improved frame or holder for the plates of active material used in secondary batteries." D. G. FITZ-GERALD, E. J. CLUBBE, and A. W. SOUTHEY. Dated May 26th.

10,400. "An improved portable battery case and safety device." D. G. FITZ-GERALD, E. J. CLUBBE, and A. W. SOUTHEY. Dated May 26th.

10,441. "Conduit electric railway." E. T. HUGHES. (Communicated by W. R. De Voe, United States.) Dated May 27th.

10,452. "Improvements in insulation of electric conductors." D. COOK. Dated May 27th.

10,472. "Improvements in machines for the manufacture of covered wire." W. H. AVIS and R. C. FISHER. Dated May 27th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

17,220. "Improved means and apparatus for commutating electric currents." S. Z. DE FERRANTI. Dated October 9th. Upon the circuit of an alternating current dynamo, at any station where may be required a commutated current, the inventor arranges a transformer, by which he reduces to a conveniently low pressure, a portion of the main high pressure current sufficient to drive a synchronising motor of small power. This motor gives motion to the barrel of a commutator. Another transformer on the main circuit, suitable to supply the current required to be commutated, is connected with the strips of the commutator barrel. The commutated current is led away by brushes in contact with the commutator barrel. The whole is arranged so that each strip of the commutator when positive is in contact with one brush and when negative is in contact with the other brush. Means are provided for bringing the motor in the first instance to the synchronising speed, and then it continues to run at this speed for an indefinite time by power derived from the current from the transformer by which it is supplied. 8 claims.

18,256. "An improved process for the electro-deposition of metal upon the surface of glass, porcelain, china, earthenware, and other materials." A. S. FORD. (A communication from abroad by H. Pottier, of Paris.) Dated October 23rd. The inventor uses a glaze or compound, consisting of borate of lead, obtained by the ordinary process of precipitation or by other means. This substance is carefully ground upon a glass plate or other suitable surface, with a suitable sufficiently inoxidisable metal, preferably silver, in a very fine state of division, and with a little essence of turpentine. An oily or greasy essence is added afterwards in sufficient quantity, which gives the necessary fluidity to the mixture. The metallic mixture is applied to the surface of the glass or other material to be treated, which is then placed in the muffle or other furnace, and heated in the usual way. The articles thus prepared are then removed and suspended by a copper or other conducting wire in a depositing bath of gold, silver, or other metal or metals, which is deposited upon them by electricity in the ordinary well known way. 2 claims.

18,723. "Improvements relating to resistance frames and the like used for electrical purposes." C. S. SNELL and WOODHOUSE AND RAWSON UNITED, LTD. Dated October 30th. Consists in one case in arranging the rods, tubes or other distance pieces parallel to the coils, in such a manner that the tension on the coils may be capable of regulation, for instance, by means of one tube sliding within another, or equivalent telescopic arrangement, capable of being clamped or otherwise fixed in any one position, a considerable range of adjustment is possible, or in place of the telescopic arrangement, a frame or frames on the lazy-tongs principle may be made use of. 5 claims.

18,976. "Improvements in arc electric lamps." T. PARKER and E. S. G. REES. Dated November 3rd. The object of the invention is to provide an arc electric lamp which is more efficient in action and the mechanism of which is more readily cleaned than in such lamps as hitherto constructed. 5 claims.

19,020. "Improvements in telephonic switching apparatus." A. R. BENNETT. Dated November 4th. The object of the invention is to provide an efficient system of telephonic switching of the kind known as direct-call or double-call, the purpose of which is to enable one subscriber to ring the bell of another without attracting the attention of the operator at the exchange, and, when required, to signal the operator without disturbing the other subscriber. 5 claims.

19,626. "Improvements in or connected with magnetic compasses for determining a ship's bearings and course." E. BAKER. Dated November 12th. Consists, speaking generally, in the combination of two representations of compass cards, without magnetised needles, together with one compass card with magnetised needles, a shadow pin and a bearing radius.

20,144. "A new or improved system of communicating visible signals and establishing electrical and telephonic connection between central, town, and district stations, and mechanism and appliances connected therewith." C. EGGAR. Dated November 19th. By these improvements electrical connection will or can be established between a central or police main station or stations in a town, and any of a series of a local or suburban cabins or district stations within the municipal boundary, to actuate and show a shaded or coloured light, semaphore, or other signal to attract the attention of the constable or policeman on or near that "beat" or local district, to let him know that he is to receive instructions by telephone in his cabin from the central station, and also enable any constable to communicate with the central station when he desires. 5 claims.

20,234. "A method of and apparatus for telephonic transmission." E. L. MAYER. Dated November 21st. The inventor employs a mutual induction coil wound with two primary windings and one secondary winding. The secondary winding he connects to earth and line in the usual manner. One of the said primary windings he places in circuit with a transmitter, a battery, and one winding of a double wound electro-magnet. The other of the said primary windings he places in circuit with a battery and with the other winding of the above mentioned double wound electro-magnet. 2 claims.

20,279. "Improvements in electric cables." G. G. M. HARDINGHAM. (A communication from the firm of Felten & Guilleaume, of Mulheim.) Dated November 21st. According to the invention, the wire conductor is rolled or drawn to a rectangular or other regular or to an irregular shape in cross section, so that the sectional form of the conductor is of such a character as to prevent its surface being closely wrapped by the paper or other insulating material; the result being that innumerable air spaces are formed between the conductor and its envelope. 4 claims.

20,545. "An improved system of telephonic exchange signalling." A. R. BENNETT and R. MCLEAN. Dated November 26th. The object of the invention is to enable the subscribers to a telephone exchange worked with metallic circuits, to speak to the operator at will, without any preliminary signalling by means of bells or indicators, and without the employment of a special signalling or service wire.

20,595. "Improvements in arc lamps." F. R. BOARDMAN. Dated November 26th. Relates to arc lamps, and it has for its object the making of a simple, compact, and efficient lamp. The invention is applicable to lamps using either a continuous or an alternating current of electricity, and the point of the arc may be kept approximately at one point (called a focussing lamp), or otherwise as desired. 3 claims.

20,718. "Electric boot and shoe grindery." P. PINCKNEY. Dated November 28th. Consists in placing articles of boot and shoe grindery in combination with some other metal or metals. Or with some other substance, or substances. But always so that the whole combination becomes a miniature voltaic electric battery. 5 claims.

20,825. "Improvements in the insulation or covering of, or for electrical cables." H. EDMUNDS and G. E. PREECE. Dated November 30th. The object of the invention is to provide means whereby a coloured covering can be very readily obtained in which the insulation of the cable is not only maintained but improved. For this purpose the inventors take natural "ozokerit" or black wax, which is refined until it becomes white, or sufficiently white, and then they mix with it a red colouring matter until the proper degree of redness has been obtained. With this material, when melted and raised to a high temperature, they prepare and saturate the white cotton braiding, or other covering or insulation, until the requisite quantity is absorbed and the proper colour obtained. 1 claim.

21,018. "Improvements in the construction of electrically controlled arc lamps." F. T. SCHMIDT. Dated December 2nd. The inventor mounts upon a suitable table above the carbons a solenoid, the plunger or core of which is in connection with two levers placed below the solenoid and mounted on suitable fulcrums, the opposite end of the levers being connected by a bar, to which is attached a cord that passes over a pulley, and to the other end of the cord is attached a weight. The before mentioned pulley has a compound groove cut therein, one portion of the groove being plain, and the other fluted in the direction of the axis, and in another portion of the pulley, or in a pulley secured to the same axis, a milled groove is cut for the reception of a cord or the like, the ends of which are respectively attached to the top and bottom carbon holders. When the full strength of the current is transmitted through the coil of the solenoid, the core or plunger of the same is lifted to the full height, the cord passing over pulley with compound groove tightened and a grooved bar brought into contact with the grooves of the pulley, thus making the connection between the bar and pulley positive. 4 claims.

21,154. "Improvements relating to electrical lamp holders." C. S. SNELL and WOODHOUSE AND RAWSON UNITED, LTD. Dated December 4th. Consists in forming the terminals in such a manner that a cylindrical tube acting as a nut on the face of the insulating disc (and containing a spring and plunger in the usual manner for capped lamps or a spring hook for uncapped lamps) is caused when rotated to pull upon a taper headed terminal screw, and by drawing it through a similarly tapered hole in the insulating disc, to cause it to receive a squeezing action, so that a flexible lead or other conductor (inserted in a deep saw or other cut longitudinally made in the terminal screw) will be tightly grasped, and good contact and a firm fastening thereby insured. 3 claims.

21,246. "Improvements in compound winding of groups of dynamos." J. M. M. MUNRO. Dated December 5th. Instead of separate pairs of conductors, the inventor uses only one pair, or its equivalent (unless, of course, in cases where the current is to be sent in various directions), and instead of winding the magnet of each machine individually with its own main wire carrying its own main current, he proposes instead of, or in addition to this, to pass the main line current, or a shunted proportion of it, in succession round the coils on all the dynamos of the group. 2 claims.

CORRESPONDENCE.

Facts and Figures on Electrolytic Chlorine and Soda.

"Tu te fâches, Jupin; donc tu as tort," says Molière's character.

"You are getting angry, Jupiter; therefore you are wrong," and Mr. Richardson, too, gets angry from the same cause, and because he has no good reasons to oppose my criticisms.

First of all, I must tell Mr. Richardson that if he applies to the editors of the ELECTRICAL REVIEW for the explanation about the delay in the publication of the conclusion of my remarks, they will tell him that they had my revised proofs before Whitsun, and that the article was delayed because they had to publish something else. If Mr. Richardson had written to the ELECTRICAL REVIEW that he was anxious to read the end of "Facts and Figures," no doubt the article would have been published sooner; but I suppose he is quite satisfied now with what he has found in my concluding article.

So long as Mr. Richardson has not refuted my statements and proved that *his copper oxide depolariser* is his own invention, that nobody before him used an *impervious diaphragm which extends from the cover downward to within a small distance of the bottom*, and that the construction of his anodes is his invention, and that they are not exactly the reproduction of the anodes used by Gibson and Le Sueur, he has no right to recriminate, and to mention "successful or unsuccessful rivality."

So much for the invention and patents of Mr. Richardson. Where there is no invention there is no patent, and he who has no patent has nothing to sell.

The field of Electrolysis is so vast, that there is plenty of room for a hundred Richardson processes, and I would never have attacked the Richardson and Holland system if I had not found in the *Paper Makers' Circular, Rag Merchants' Gazette and Price Current* the reports of the eminent experts who examined the Snodland plant, and in which the praises of the Richardson-Holland system were almost clandestinely sung in a very extraordinary manner, to the prejudice of all other electro-chemists. My excuse and justification are that the glorification of the Gibson-Le Sueur-Richardson-Holland anodes seemed to me so preposterous, that I could not help protesting against the undeserved diploma granted to Richardson-Holland by experts who, by doing so, were pitilessly running down the systems invented by other electro-chemists, perhaps without knowing them. This certainly was not fair play.

Mr. Richardson may not agree with me on the following point, but, in my mind, it is preferable to have a very good, efficient and original system for producing chlorine and caustic soda by electrolysis, which works for the present on a small scale, than to have a large factory where a process is worked which any intelligent chemist and alkali maker can work in almost the same manner, and even better and cheaper, if some small alterations and improvements are introduced. Mr. Richardson speaks of the large quantity of chlorine and soda produced at Snodland, and of which he sends samples. We have already heard this little story, which was repeatedly told by anonymous writers from Snodland, who, after the Greenwood experiments had taken place, were sending letters to the ELECTRICAL REVIEW, such as the one dated January 26th, 1892, from which I extract the following, where the Greenwood process is disparaged by means of the same argument, viz., the want of large production.

> Now, I would like to point out, before the British public is asked to subscribe to any concern of this character, that the pioneers, or "exploiters," of the invention or inventions should first conclusively demonstrate that they can turn, and are turning, out the products they claim to be able to produce economically, commercially, in commercial quantities, and in a commercial manner.
>
> . . . . . .
>
> Nearly a year before Greenwood's patents were even applied for, an electrical process of a somewhat similar nature was for several months worked at a large paper mill in Kent, where it was inspected by several practical paper makers; and within a month or so this process will, I believe, be undergoing such a further practical commercial demonstration as I have indicated, *i.e.*, turning out by means of electricity some 10 or 20 tons a week.

(Since January, 1892, seventy weeks have elapsed. Have Messrs. Richardson and Holland turned out not twenty, but ten tons only, a week? Mr. Richardson speaks of working his tank with an E.M.F. of 3 volts, instead of 6, in almost the same manner as in January, 1892, he was talking of turning out from 10 to 20 tons a week.)

. . . . . .

> The work I have alluded to is being carried out at some considerable expense by the Electrolytic Caustic Soda and Chlorine Trust at their works at Snodland, on the Medway.
>
> I would recommend investors to await the result of the Electrolytic Trust's operations, or work of a really commercial character, before investing in any process for the manufacture of caustic soda or bleach by electricity.

What right have the people who made such unjustifiable statements to complain of my notes and comments on their process. A writer may have a very rich and influential publisher who advertises, pushes and sells his very poor book, while numbers of good men, who are not rich, cannot find anyone who will incur the risk of printing their manuscript. This is a mere question of money, and not at all of superiority or talent.

The electricians who are supported by rich people, and who have a long purse at their disposal, can boast that they are the only ones to produce, on a large scale chlorine and soda. But this is insufficient to persuade those who know what electrolysis is, that the system which works satisfac-

torily on a small scale will not work satisfactorily on a commercial scale; it shows only that the capitalists who were so bold as to start a large installation at Snodland deserve all our most sincere thanks, because they have encouraged, or will encourage, other people to invest money in electrolysis also. There is no mistake, they made the market for similar enterprise more than for themselves, as, unfortunately for them, the Richardson-Holland process is not so perfect that it will compete with other electrolytic methods. They can manufacture soda and chlorine at Snodland or elsewhere, like people in Manchester manufacture cottons and tickings, but they must abandon the idea that the Richardson-Holland invention will revolutionise the alkali trade.

Mr. Richardson says: "If I or anyone else will say where an electrolytic apparatus can be inspected which has turned out a single ton of 70 per cent. soda per week, in this country or any other, we will go to see it."

I know that they like to know and see what others do. I do not say that there is any harm in being inquisitive, but there is a limit to everything. Why did the Snodland company write me the following letter:—

The Electrolytic Caustic Soda and Chlorine Trust, Limited.
23, Queen Victoria Street,
London, E.C., *April 29th*, 1893.

Dear Sir,—I see from the official paper of the Patent Office that you have made application for a protection order for patent No. 8,177, dated April 22nd, 1893, for "Improvements in electrolysis," and we shall feel much obliged if you will kindly supply us with particulars, as we are interested in the subject.—Yours faithfully,

JNO. A. J. SHAW, *Secretary*.

Emile Andreoli, Esq.

I am not vexed at all by Mr. Richardson's sarcasms; I may be, or have been, an unsuccessful rival in the direction of electrolytic bleach liquor—*Fit faber fabricando*. He may rest assured that when I come forward I will publish reports in the electrical and technical press, and not in the monthly *Paper Makers' Circular and Rag Merchants' Gazette and Price Current*, and I will invite criticism instead of avoiding it.

In the meantime I will ask Mr. Richardson to answer first the following questions: How much chlorine does he obtain per ampère hour? How much caustic soda does he obtain per ampère hour? What is the E.M.F. he requires?

Mr. Richardson ought not to be so angry with me; my criticisms have already produced good results, since he says his potential has been reduced to 5 volts, and that he will reduce it to 3 volts. Mr. Richardson has no doubt been inspired by reading the specification published last week, in which Mr. Desmond FitzGerald says that 2·3 volts are theoretically requisite in addition to the E.M.F., to overcome the resistance of the circuit and the spurious electromotive force. Mr. Richardson already speaks of a progress he has realised since my criticisms have been published, and says that "his potential is being steadily reduced (already from 6 to 5 volts, including length of mains), without in the slightest degree diminishing the density of current, or adding to the cost of the apparatus or its working, and before long it is hoped to bring the potential down to below 3 volts, by a judicious use of a depolariser."

Three volts instead of 6—this is quite a jump, and I shall heartily congratulate him when he will have succeeded in doing it. It is a pity he did not accomplish this feat before the eminent experts issued their report.

Boasts and abuses are not arguments. Now that Mr. Richardson has written a letter, he must go on and reply to my "Facts and Figures on his Electrolytic Chlorine and Soda."

There is also a very simple way of settling this discussion raised by the pretensions of the Snodland people to supremacy.

Let us—he and I—start an installation of two tanks, which will work for a week, a fortnight or more if desired, under the supervision of a committee of electricians, chemists, paper makers and alkali makers.

A programme containing a series of questions will be prepared, to which the experts will have to reply. I am sure other electro-chemists, such as Greenwood, Le Sueur, &c., will join us in this competition.

The one who obtains the least chlorine and soda, and whose system will be considered as inferior for originality and efficiency, and will require the highest E.M.F., will pay the fees of the experts.

If Mr. Richardson accepts this challenge, I am prepared to submit to the decision of the experts chosen by the ELECTRICAL REVIEW, *Electrician*, *Electrical Engineer*, *Engineering*, *Engineer*, *Industries*, and other technical papers designated by Mr. Richardson.

Emile Andreoli.

June 5th, 1893.

Paralleling of Alternators.

I feel that Messrs. Hammond and Company are entitled to a reply from me to their letter published in your issue of the 2nd inst.

In the first place I have the pleasure of knowing Mr. Hammond, and have been privileged to see much of the work he has carried out, and no one could feel a greater regard for himself, and what he has done for electric lighting in this country, than I do myself.

On the question at issue, it affords me pleasure to reply to Mr. Hammond's enquiry, and to state that the central station at Prescot, Lancashire, is the one I had in mind. This is now under the control of my friend, Mr. S. V. Clirehugh, who happens to have been connected with another station which I had occasion to refer to in my remarks.

I am not aware in what way I can so express my personal knowledge of facts as to assure Mr. Hammond that Ferranti and Mordey-Raworth plant stations have been and are depending regularly upon parallel running.

If we take Deptford for the first; Bankside and Bournemouth for the second type plant, it is self-evident to those acquainted with the trunk mains and switchboards therein employed that this system of running the generators must be employed. I am not prepared to publish much more than this, but the facts can be verified in a few minutes by taking the trouble to make a personal inspection.

It is also, I am aware, the case that paralleling has for a long time, and is, practised at the stations due to Mr. Hammond's initiative, and perhaps one may learn something new from their arrangements for doing this, as has been the case with myself, but it must be confessed that their switchboards are adapted for either "districting" or "buss-barring" by the mere opening or closing of a switch. In the other cases no alternative to the latter is arranged for.

As the writer happened to represent an electrical company at the Board of Trade inquiry in 1889, he well remembers the arguments used by contending counsel and expert witnesses, but from memory it does not seem that parallel running was a point to which special prominence was given by any of the parties whose evidence was recorded.

To the paragraph of the letter referring to Newcastle, it is only necessary to point out that the engines used for driving the alternators there are *not* those which form part of the Mordey-Raworth system, and that no one has ever cited this supply station as an argument against the Brush Company, whose plant elsewhere shows what could probably have been done at Newcastle had the arrangements of the Brush Company been carried out in their entirety.

The letter which appeared on the 26th ult. has done something to assist those interested in the problem, if only as the means of bringing to light such an assurance as is contained in Messrs. Hammond and Co.'s letter, bearing upon the stations for which they are responsible.

Taking the question fairly, I think it may be held proven that, under proper conditions of design, either Lowrie-Hall, Ferranti, or Mordey-Raworth plant stations can be run satisfactorily and regularly in parallel.

As to priority, in April, 1889, before Major Marindin, Prof. Forbes stated, "He found the parallel working there," *i.e.*, West Brompton, "succeeded in a way that was absolutely unexceptionable in regard to switching on a dynamo; there was not the slightest flicker." In June and July, 1889, I visited the Brompton station several times, and certainly it was not running parallel as a regular thing, although it was known to be possible.

The absence of a synchroniser on the board causes me to remember this distinctly.

Between these dates—on May 23rd, 1889—Mr. Wm. Mordey read his paper on "Alternate Current Working," in which he described a series of trials which were afterwards shown to visitors to the Brush works.

Fleming's "Alternate Current Transformer," page 225, states Lowrie-Hall alternator runs perfectly in parallel. This is, of course, agreed to, but on my visit to Bournemouth in September, 1889, I saw the alternating Mordey plant arranged to run parallel. I have other papers on the subject, but am not prepared to publish their contents.

In any case, Messrs. Ferranti, Lowrie and Mordey, must have been working at the question at one and the same time, and if Mr. Hammond desires, I think we are quite prepared to include his name with those to whom he takes exception.

So far as I now know, the first station to run parallel regularly was Bournemouth, very closely followed by Brompton, while Deptford was but a few days behind the latter, if at all. At the best the question is one of curiosity rather than of practical importance, but it would much interest me if Messrs. Hammond & Co. would publish the date when regular parallel running at Brompton commenced.

Charles H. Yeaman.

My attention has been called to two letters on the above subject appearing in your issues of May 26th and June 2nd respectively, and in both letters reference has been made to the practice of this company, and to which I beg to say a few words in reply:—

1 (*a*). Parallel running at this station has not been introduced for *continuous work*, because I consider our present practice more economical.

(*b*). In the event of an accident inside the station or on the lines, the result might be more serious than I at present care to contemplate.

2. Parallel running is now done, *if necessary or advisable*, with as much facility as I have seen it done elsewhere, the House-to-House Company's station at West Brompton not excepted.

As to the respective merits of Messrs. the Brush Company *versus* Messrs. Hammond & Co., they must fight their own battles.

R. C. Jackson,
Engineer and Manager Newcastle-on-Tyne Electric Supply Company, Limited.

Figure of Merit of Mirror Galvanometers.

In reply to the query from J. B. Brantingham, perhaps the following quotation may help him. Of course, the small E.M.F. will be easily derived by Ohm's Law.

"The astatic mirror galvanometer is capable of being adjusted to measure currents as low as the 50 millionth of a milliampére with a coil of from 5,000 to 10,000 ohms."

"Prof. Langley finds that an instrument of 20 ohms resistance is capable of being used with perfect accuracy for the measurement of the two millionth of a milliampère." —Excerpt, Thomson on "Electric Measuring Instruments," *Proc.* Phil. Soc. Glas., April 20th, 1887.

I have used these sensibilities myself, but must say that for average work they require such extreme weakening of the controlling field, that it is beyond the patience of the ordinary experimenter to obtain practical results. For further information I would refer your enquirer to the paper mentioned.

C. H Y.

Train Lighting.

I have to thank you faithfully for publishing my letters on this subject and in response to your editorial note I send for your perusal my specification of December 10th, 1881, and Mr. Houghton's of May 23rd, 1883, and in the event of Mr. Houghton continuing to wear plumes that do not belong to him, I will forward to you for perusal his and Mr. Knight's original letters already referred to.

J. Evelyn-Liardet.

June 1st, 1893.

Lest you may consider it necessary to make any decisive remark on Messrs. Stroudley and Houghton's patent as compared to that of my invention, in reference to any difference existing between them, I desire to say that neither Mr. Ward or Mr. Tommasi entered into details as I did, and moreover, Mr. Houghton does not deny his and Mr. Knight's official assurances on behalf of the L. B. and S. C. Railway Company not to use my plans and specifications in any way to my prejudice; these assurances were given while and after Mr. Houghton had my plans and specifications in his possession, handed to him by Mr. Knight and upon which their trains were lighted. If my plans and specifications were of no use why give the guarantees. I do not like troubling you with the guarantees. If you desire it I will send you certified copies.

My invention fully provided "to enable the plant to safely run at varying speeds, join up and disconnect the circuits and maintain a constant light without the aid of a travelling attendant" other than the guard who acted in both capacities.

If the invention was very much patented before 1881, "surely I am correct in saying Mr. Houghton" plumes himself with feathers that belong to some one else.

J. Evelyn-Liardet.

June 3rd, 1893.

Joel's Motors.

Your criticism of our "Joel Alternating Current Electromotors" appears to us to be somewhat one-sided; you do not publish a description of the motor, and your readers, therefore, cannot estimate the criticism at its value.

We sent you a letter, first, asking you if you would like to have the description of our Joel alternating current motor, and the blocks to illustrate it; our messenger brought us word that you would like them, and we sent them accordingly. The subject of alternating current motors is of surpassing interest just now, and we described several distinct novelties, such as the making field magnet cores and poles, and Paccinotti toothed armature cores, *entirely* of soft iron wire, a special commutating switch and the connections for motors, which, as far as we know, has not appeared in your REVIEW; the application of the motor to lift gear, pneumatic despatch tubes and other purposes, the originality of which was our reason for sending the description to you.

If, after consideration with the matter before you, you decided not to use them, then the description should at once have been returned to us, and not have been kept by you for nearly a fortnight without any comment.

We submit that, after deciding not to avail yourselves of our matter, you should not have criticised it in your journal, and especially without our knowledge or consent; the whole subject should have been treated as private and confidential, and we consider you have treated us with but scant courtesy.

We understand you sent our description to Mr. Kennedy, and he was the writer of the criticising article. Mr. Kennedy (not the professor), as your readers are aware, has a patent of his own for an alternating current motor, dated some years after ours; he describes, and has used our laminated fields and of exactly the same shape, as we describe; we therefore do not think that he is an unprejudiced critic, and possibly his remarks upon laminated fields, able electricians, leading electricians, &c., may be better appreciated. Had the article been signed by him, we should not have taken any notice of it.

Henry F. Joel & Co.

June 5th, 1893.

[In our article we touched upon the novelties to which our correspondents allude, and stated our reasons for not wishing to encumber our pages with the inventor's own description, and a number of blocks, which could have no interest to the electrician proper. Messrs. Henry F. Joel & Co. seem to have peculiar ideas concerning journalism, but that is not the only thing in which one of the partners stands alone. Perhaps it may be quite new to the Finsbury firm to know that descriptive matter such as theirs has sometimes to stand over as many months as in this case it did weeks, and that when MS. is unreservedly sent to a journal, it is quite in the discretion of the editors to publish it without comment, to comment without publishing, or to place it in the usual receptacle for rejected matter. Moreover, we have yet to learn that when the same thing is sent the round of the technical press, there is any journalistic etiquette which obliges one to treat the subject privately and confidentially; and it is not an uncommon thing for a technical journal to utilise the services of writers outside the editorial office, for the purpose of putting together the views which the editors have formed, and which they have not time to write up for themselves. Messrs. Joel & Co. may rest assured that an

unsigned article expresses the editorial opinion, and that, whoever the writer, the latter is never asked to supply copy unless under request from the editor-in-chief, who, in this case, as in others, accepts the full responsibility of the unsigned article. "The subject of alternating current motors is of surpassing interest," and probably no man is better qualified than Mr. Rankin Kennedy for the purpose of criticising the very apparatus which has rendered his name an authority throughout the world.—EDS. ELEC. REV.]

Relative Safety or Danger of Electric Light Current.

The letter of your correspondent, Mr. Arthur Shippey, scarcely touches the question as far as direct, or as we prefer to call it, continuous, current is concerned. His strictures upon the use of alternating current are so put that they may easily be taken to refer to continuous current also. This, however, is far from being the case.

Admitting for the moment the risk of danger from an inrush of current from the mains, we hold that in the case of continuous current, no such accident can reach the patient with our controller, or any similar apparatus. Of this we have now had some nine months' experience. We have used "current from the main" (supplied to us by the Electricity Supply Corporation) through our controller, upon scores of patients sent to us for treatment, from a small fraction of a milliampère in some cases, to 250 milliampères (administered in a dipolar bath) in others, without the least semblance of an accident. The shunt circuit is a valuable addition to the safeguards, as was pointed out by Dr. Hedley in the *Lancet* of April 9th, 1892, and to which we referred in our previous letter.

We do not, however, recommend that the comparatively large currents required for cautery work (often 10 ampères or more) be used direct from the mains, or even through our controller, for several reasons, not the least of which is that the resistance in the shunt or operating circuit (that of the cautère only) is then less than that in the main circuit. For such work small accumulators are decidedly preferable, both as regards safety, cheapness, and convenience.

With alternating current matters are less simple, for, in the first place, a magnetic cut-out will not answer, and we are not aware of any fuse which is even approximately as accurate. Possibly Mr. Shippey's fuse may answer, but he, himself, says it is locked up for the present.

Further, alternating current cannot, as yet, be readily transformed into continuous, and hence only such operations as are generally classed as Faradic by medical men, can be performed with it. But as far as this is convenient, we believe the Week's transformer will do all that is required. Of the value of alternating current from dynamo circuits for general treatment purposes, little is at present known; but Gautier and Larat, of Paris, have recently put forth a claim, based upon experiments, that it will do what other forms of current will not. Some particulars of this were given in the ELECTRICAL REVIEW at the time.

And now a word or two as to the actual risk from the mains. We can understand Dr. Waite's fears, though not to the extreme point to which he carried them, as regards America, where accidents due to imperfect or careless installation work are, or were, prevalent to a serious extent. But in this country such accidents as lead to a sudden inrush of current to our houses are scarcely known. We think, therefore, that the possible danger has been much exaggerated, even putting aside any special method of control inside the building. We do not know the percentage of such catastrophes; perhaps some of our electric light engineers will give such information, but we doubt much if in using "current from the main" any greater risk is run than every one faces any day he walks abroad or travels in a railway train.

We should like to add something, as practical operators, upon the general convenience of "current from the main" and the special advantages of using in circuit, as we must by this method, such high resistance that the resistance of the body treated forms only a small part of the whole, but this would trespass too much on your space. We cannot, however, conclude without remarking that we are not taking this view simply to support our apparatus. The apparatus is rather the result of our belief in the safety of "current from the main." We supply batteries as well as controllers, and would as soon sell one as the other. At the same time we yield to none in our desire to secure the safety of the patient as well as the convenience of the physician.

The Electro-Medical Apparatus Company,
LAWRENCE AND KIRK, *Managers.*

June 5th, 1893.

Prevention and Control of the Sparking of Dynamos, &c.

May I be permitted to point out an error which has crept into your description of my improvements in dynamo machines? It is not the case that the "additional winding" which I put on tends to magnetise the field. What my commutator coils do is to reverse the armature sections close against the horns of the poles, which are strengthened by the armature reaction, instead of near the horns which are weakened, as is usual. The result of this is that *the current in the ordinary winding of the armature tends to magnetise its own field, instead of to demagnetise it.*

The 40-unit armature made by Messrs. Mavor and Coulson, which was on view on the evening of the discussion of my paper, merely has the connections to the commutator segments joined to the main winding at the opposite end of the armature to the commutator, so that the conductors pass once across through the magnetic field. This is proved experimentally to be quite sufficient to secure the desired result in armatures having only one turn per section.

W. B. Sayers.

Electric Heating and Other Things.

How curious it is that self-evident applications of electricity are patented over and over again, the real novelty of most of the minor inventions being in the terms applied to the articles or suggestions by the patentee rather than in any new discovery or development. The latest example is very prettily represented by your correspondent, "L. M.," in the issue for the 2nd inst. Now, that gentleman entirely ignores that the vacuum of an ordinary incandescent lamp is a vacuum by courtesy, and not such *de facto*. There is no mystery in a true vacuum acting as an isolating thermic screen. Screens may be of two kinds: the first including those which by their absorbing power shield the space behind them, and the second those which by their non-conducting power—to use the terms and ideas of the older scientific school—block off the force more or less perfectly. A copper sheet is a screen to alternating magnetic fields, and falls within the first class; a sheet of ebonite to electric currents in the second.

There is nothing novel in the use of an electric lamp as a resistance heater. This, to the writer's knowledge, was an application which was in practical use four years ago, and many a cup of lukewarm tea has been so prepared. As a hand-warmer, and even for softening sealing wax, the incandescent lamp has had its use. Again, the air space round a glow lamp is most detrimental for high efficiency heating. Air only acts well in this way when in motion. Radiation is always assisted by convection where good results are to be obtained, and unless Messrs. Miller and Woods have upset Nature's laws, the heater they would exploit will be easily beaten by those following a little more nearly the rules of design. Everybody knows that only something like 2½ per cent. to 3 per cent. of the watt energy supplied is utilised and emitted as light waves by an incandescent lamp. As to the vacuum jacket mentioned in "Electric Heating and the Load Factor," a question suggests itself. Have your correspondents ever heard of a gentleman called Prof. Dewar?

I am unable to see that the vacuum mentioned was given in reference to that existing inside the bulb of a glow lamp, and in this way your correspondents have created a stumbling block which previously did not exist, and immediately fallen over it themselves.

The Writer of the Article.

London, *June 2nd*, 1893.

Cooking and Heating by Electricity.

In our letter in your last issue on this subject please read (page 671, line 13), "the less the time in which the *radiation* (not evaporation) can take place the higher the efficiency."

Miller & Woods.